“Free Electron Theory”.

1. What does the conductivity of metals depend upon?
a) The nature of the material
b) Number of free electrons
c) Resistance of the metal
d) Number of electrons
View Answer
Answer: b
Explanation: The conducting property of a solid is not a function of a total number of electrons in the metal, but it is due to the number of valance electrons called free electrons.

2. The free electrons collide with the lattice elastically.
a) True
b) False
View Answer
Answer: a
Explanation: The free electrons move randomly in all directions. The free electrons collide with each other and also with the lattice Elastically, without loss in energy.

3. What happens to the free electrons when an electric field is applied?
a) They move randomly and collide with each other
b) They move in the direction of the field
c) They remain stable
d) They move in the direction opposite to that of the field
View Answer
Answer: d
Explanation: The free electrons move in the direction opposite to that of field direction. Since they are assumed to be a perfect gas as they obey classical kinetic theory of gases and the electron velocities in the metal obey the Maxwell-Boltzmann statistics.

4. Thermal conductivity is due to photons.
a) True
b) False
View Answer
Answer: a
Explanation: Thermal conductivity is due to both photons and free electrons and not just photons.

5. Which of the following theories cannot be explained by classical theory?
a) Electron theory
b) Lorentz theory
c) Photo-electric effect
d) Classical free electron theory
View Answer
Answer: c
Explanation: Classical theory states that all free electrons will absorb energy. This theory cannot explain the photo electric effect.

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6. Which of the following theories can be adopted to rectify the drawbacks of classical theory?
a) Compton theory
b) Quantum theory
c) Band theory
d) Electron theory
View Answer
Answer: b
Explanation: In classical theory, the properties of metals, such as electrical and thermal conductivities are well explained on the assumption that the electrons in the metal freely moves like the particles of a gas. Hence it can be used to rectify the drawbacks of classical theory.

7. What is the level that acts as a reference which separated the vacant and filled states at 0K?
a) Excited level
b) Ground level
c) Valance orbit
d) Fermi energy level
View Answer
Answer: d
Explanation: Fermi energy level is the maximum energy level up to which the electrons can be filled at 0K. Thus it acts as reference level which separated the vacant and filled states at 0K.

8. A uniform silver wire has a resistivity of 1.54×10^{-18} ohm/m at room temperature. For an electric field along the wire of 1 volt/cm. Compute the mobility, assuming that there are 5.8×10^{28} conduction electrons/m^3.
a) 1.54 m^2/Vs
b) 6.9973m^2/Vs
c) 6.9973×10^{-3} m^2/Vs
d) 0.69973m/s
View Answer

Answer: c
Explanation: Mobility of the electrons = 1/ρne
Mobility = 6.9973×10^{-3} m^2/Vs.

9. Calculate the drift velocity of the free electrons with mobility of 3.5×10^{-3} m^2/Vs in copper for an electric field strength of 0.5 V/m.
a) 3.5 m/s
b) 1.75×10^{3} m/s
c) 11.5 m/s
d) 1.75×10^{-3} m/s
View Answer
Answer: d
Explanation: Drift velocity = μE
Drift velocity = $3.5\times10^{-3}\times0.5 = 1.75\times10^{-3}$m/s.

10. The Fermi temperature of a metal is 24600K. Calculate the Fermi velocity.
a) 0.5m/s
b) 1.38m/s
c) 0.8633×10^{6}m/s
d) 9.11×10^{-3}m/s
View Answer
Answer: c
Explanation: $E_F = K_B\, T_F = ½\, mv^2_F$
$v_F = \sqrt{\frac{2\times K_B\times T_F}{m}}$
$v_F = 0.8633\times10^{6}$m/s.

"Properties of Semiconductors – 1".

1. How does a semiconductor behave at absolute zero?
a) Conductor
b) Insulator
c) Semiconductor
d) Protection device
View Answer
Answer: b
Explanation: A semiconductor is a solid which has the energy band similar to that of the insulator. It acts as an insulator at absolute zero.

2. Semiconductor acts as an insulator in the presence of impurities.
a) True
b) False
View Answer
Answer: b
Explanation: When the temperature is raised or when an impurity is added, their conductivity increases. Conductivity is inversely proportional to temperature.

3. How is the resistance of semiconductor classified?
a) High resistance
b) Positive temperature co-efficient
c) Negative temperature co-efficient
d) Low resistance
View Answer
Answer: c
Explanation: Semiconductors have negative temperature co-efficient. The reason for this is, when the temperature is increased, a large number of charge carriers are produced due to the breaking of covalent bonds and hence these electrons move freely and gives rise to conductivity.

4. What are the charge carriers in semiconductors?
a) Electrons and holes
b) Electrons
c) Holes
d) Charges
View Answer
Answer: a
Explanation: In conductors, electrons are charge carriers. But in semiconductors, both electrons and holes are charge carriers and will take part in conduction.

5. Which of the following is known as indirect band gap semiconductors?
a) Germanium
b) Nickel
c) Platinum
d) Carbon
View Answer
Answer: a
Explanation: The elemental semiconductor is made up of a single element from the fourth column elements such as Germanium. Here recombination takes place takes place via traps. It is called indirect band gap semiconductors.

6. Which column elements are combined to make compound semiconductors?
a) First and fourth
b) Fifth and sixth
c) Second and fourth
d) Third and fifth
View Answer

Answer: d
Explanation: The compound semiconductors are made by combining the third and fifth column elements. Such as GaAs are made by combining third and fifth column elements.

7. Compound semiconductors are also known as direct band gap semiconductors.
a) True
b) False
View Answer
Answer: a
Explanation: In compound semiconductors, recombination takes place directly and its energy difference is emitted in the form of photons in the visible or infrared range. Hence the compound semiconductors are also known as direct band gap semiconductors.

8. How are charge carriers produced in intrinsic semiconductors?
a) By pure atoms
b) By electrons
c) By impure atoms
d) By holes
View Answer
Answer: c
Explanation: Impure semiconductors in which the charge carriers are produced due to impurity atoms are called extrinsic semiconductors. They are obtained by doping an intrinsic semiconductor with impurity atoms.

9. What type of material is obtained when an intrinsic semiconductor is doped with pentavalent impurity?
a) N-type semiconductor
b) Extrinsic semiconductor
c) P-type semiconductor
d) Insulator
View Answer
Answer: a
Explanation: N-type semiconductor is obtained by doping an intrinsic semiconductor with pentavalent impurity atoms.

10. What type of material is obtained when an intrinsic semiconductor is doped with trivalent impurity?
a) Extrinsic semiconductor
b) Insulator
c) N-type semiconductor
d) P-type semiconductor
View Answer

Answer: d
Explanation: P-type semiconductor is obtained by doping an intrinsic semiconductor with trivalent impurity.

"Properties of Semiconductors – 2".

1. Which method can be used to distinguish between the two types of carriers?
a) Hall effect
b) Rayleigh method
c) Doppler effect
d) Fermi effect
View Answer
Answer: a
Explanation: When a conductor carrying current is placed in a transverse magnetic field, an electric field is produced inside the conductor in a direction normal to both the current and the magnetic field. This phenomenon is known as the Hall Effect.

2. Find the resistance of an intrinsic Ge rod cm long, 1mm wide and 1mm thick at 300K.
a) 2.32 ohm
b) 5314 ohm
c) 4310 ohm
d) 431 ohm
View Answer
Answer: c
Explanation: Conductivity of an intrinsic semiconductor = $n_i e(\mu_e+\mu_h)$
Conductivity = 2.32
Resistance = ρl/A = l/(conductivy × A)
Resistance = 4310 ohm.

3. A semiconducting crystal 12mm long, 5mm wide and 1mm thick has a magnetic flux density of 0.5Wb/m^2 applied from front to back perpendicular to largest faces. When a current of 20mA flows length wise through the specimen, the voltage measured across its width is found to be 37μV. What is the Hall coefficient of this semiconductor?
a) 37×10^{-6} m^3/C
b) 3.7×10^{-6} m^3/C
c) 3.7×10^{6} m^3/C
d) 0
View Answer
Answer: b
Explanation: Hall coefficient = $(V_H\ b)/(I_H\ B)$
Hall coefficient = 3.7×10^{-6} m^3/C.

4. The intrinsic carrier density at room temperature in Ge is $2.37 \times 10^{19}/m^3$. If the electron and hole mobilities are 0.38 and 0.18 m^2/Vs respectively. Calculate its resistivity.
a) 0.18ohm m
b) 0.460ohm m
c) 0.4587ohm m
d) 0.709ohm m
View Answer
Answer: d
Explanation: Conductivity = $n_i e(\mu_e + \mu_h)$
Conductivity = 2.12352/ohm m
Resistivity = 1/Conductivity
Resistivity = 0.4709ohm m.

5. A silicon plate of thickness 1mm, breadth 10mm and length 100mm is placed in a magnetic field of 0.5 Wb/m^2 acting perpendicular to its thickness. If 10^{-3} A current flows along its length, calculate the Hall voltage developed, if the Hall coefficient is 3.66×10^4 m^3/Coulomb.
a) 1.83×10^{-3} Volts
b) 3.66×10^{-4} Volts
c) 0.5 Volts
d) 25.150 Volts
View Answer
Answer: a
Explanation: $V_H = (R_H I_H B)/t$
$V_H = 1.83 \times 10^{-3}$ Volts.

6. The conductivity of germanium at 20°C is 2/ohm m. What is its conductivity at 40°C? E_g=0.72eV
a) 1.38×10^{-23}/Ohm m
b) 1.0002/Ohm m
c) 293/Ohm m
d) 313/Ohm m
View Answer
Answer: b
Explanation: $\sigma = Ce^{(-E/2KT)}$
$\sigma 1/\sigma 2 = e^{(-E/2KT)}/e^{(-E/2KT)}$
$\sigma 2$ = 1.0002/ Ohm m.

7. What is the Fermi energy of a n-type semiconductor?
a) E
b) $E_{(F)} = (E_c + E_v)/2$

c) $E_F = (E_c + E_d)/2$
d) $E_F = (E_v + E_a)/2$
View Answer
Answer: c
Explanation: The Fermi energy level of n-type semiconductor lies exactly between the acceptor energy level and the maximum energy level of valence band. Therefore the Fermi energy level of n-type semiconductor is $E_F = (E_c + E_d)/2$.

8. $E_F = (E_c + E_v)/2$, this represents the Fermi energy level of which of the following?
a) Extrinsic semiconductor
b) N-type semiconductor
c) P-type semiconductor
d) Intrinsic semiconductor
View Answer
Answer: d
Explanation: The Fermi energy of an intrinsic semiconductor is $E_F = (E_c + E_v)/2$. That is the Fermi energy level exactly lies between the lowest energy level of conduction band and highest energy level of valence band.

9. For semiconductors, the resistivity is inversely proportional to the temperature for semiconducting materials.
a) True
b) False
View Answer
Answer: a
Explanation: For semiconductors, the resistivity is inversely proportional to the temperature of the material, that is, it has a negative temperature coefficient. When the temperature of the semiconductor is increased, large numbers of charge carriers are produced due to the breaking of covalent bonds. These charge carriers move freely, hence conductivity increases and therefore the resistivity decreases.

"Hall Effect".

1. When does a normal conductor become a superconductor?
a) At normal temperature
b) At Curie temperature
c) At critical temperature
d) Never
View Answer
Answer: c
Explanation: The temperature at which a normal conductor loses its resistivity and becomes a superconductor is known as transition temperature or critical temperature.

2. In which of the following does the residual resistivity exist?
a) Impure metal at high temperature
b) Pure metal at low temperature
c) Pure metal at high temperature
d) Impure metal at low temperature
View Answer
Answer: d
Explanation: When the temperature is reduced to 0K, the resistivity of the impure metal doesn't become zero, because there exist some impurities which gives rise to minimum resistivity known as residual resistivity.

3. Meissner effect occurs in superconductors due to which of the following properties?
a) Diamagnetic property
b) Magnetic property
c) Paramagnetic property
d) Ferromagnetic property
View Answer
Answer: a
Explanation: A diamagnetic material has a tendency to expel magnetic lines of forces. Since the superconductor also expels magnetic lines of force it behaves as a perfect diamagnet. This behaviour is first observed by Meissner and is hence called Meissner effect.

4. What happens when a large value a.c. current is passed through superconductors?
a) Conductivity increases
b) Superconducting property is destroyed
c) It acts as a magnet
d) It becomes resistant
View Answer
Answer: b
Explanation: When a large value of a.c. current is applied to a superconducting material it induces some magnetic field in the material and because of this magnetic field, the superconducting property of the material is destroyed.

5. How is persistent current produced in supermagnets?
a) By passing ac current
b) By magnetising it
c) By passing dc current
d) By increasing the resistance
View Answer

Answer: c
Explanation: When dc current of large magnitude is once induced in a super conducting ring then the current persists in the ring even after the removal of the field. This current is called persistent current. This is due to diamagnetic property. The magnetic flux inside the ring will be trapped in it and hence current persists.

6. Superconductors can be used as a memory or storage elements in computers.
a) True
b) False
View Answer
Answer: a
Explanation: Since the current in superconducting ring can flow without any change in its value, it can be used as a memory or storage element in computers.

7. Superconducting tin has a critical temperature of 3.7K at zero magnetic field and a critical field at 0.0306 Tesla at 0K. Find the critical field at 2K.
a) 0.0306 Tesla
b) 7.4 Tesla
c) 0.02166 Tesla
d) 0 Tesla
View Answer
Answer: c
Explanation: Critical field, $H_c = H_0 [1-T^2/(T_c)^2)]$
Critical college = 0.02166 Tesla.

8. Calculate the critical current for a wire of lead having a diameter of 1mm at 4.2 K. Calculate temperature for lead is 7.18 K and $H_c = 6.5\times10^4$ A/m. Critical field is 42.758×10^3 A/m.
a) 3.5593 A
b) 27.3 A
c) 46.67 A
d) 134.26 A
View Answer
Answer: d
Explanation: Critical current $I_c = 2\pi r H_c$
I_c = 134.26 A.

"Classification of Semiconductors".

1. What is the energy level below which all levels are completely occupied at Zero Kelvin called?
a) Boson Energy
b) Fermi Energy
c) Stable Energy

d) Ground Energy
View Answer
Answer: b
Explanation: Fermi energy is said to be the energy of the highest possible occupied energy level at 0 K. Below this level, all the states are completely occupied.

2. What are the current carriers in semiconductors?
a) Electrons and Protons
b) Electrons and Nucleons
c) Electrons and Photons
d) Electrons and Holes
View Answer
Answer: d
Explanation: Electrons and holes are the two current carriers in semiconductors. Electrons are negatively charged while holes are positively charged. Their movement gives rise to a current in the semiconductor.

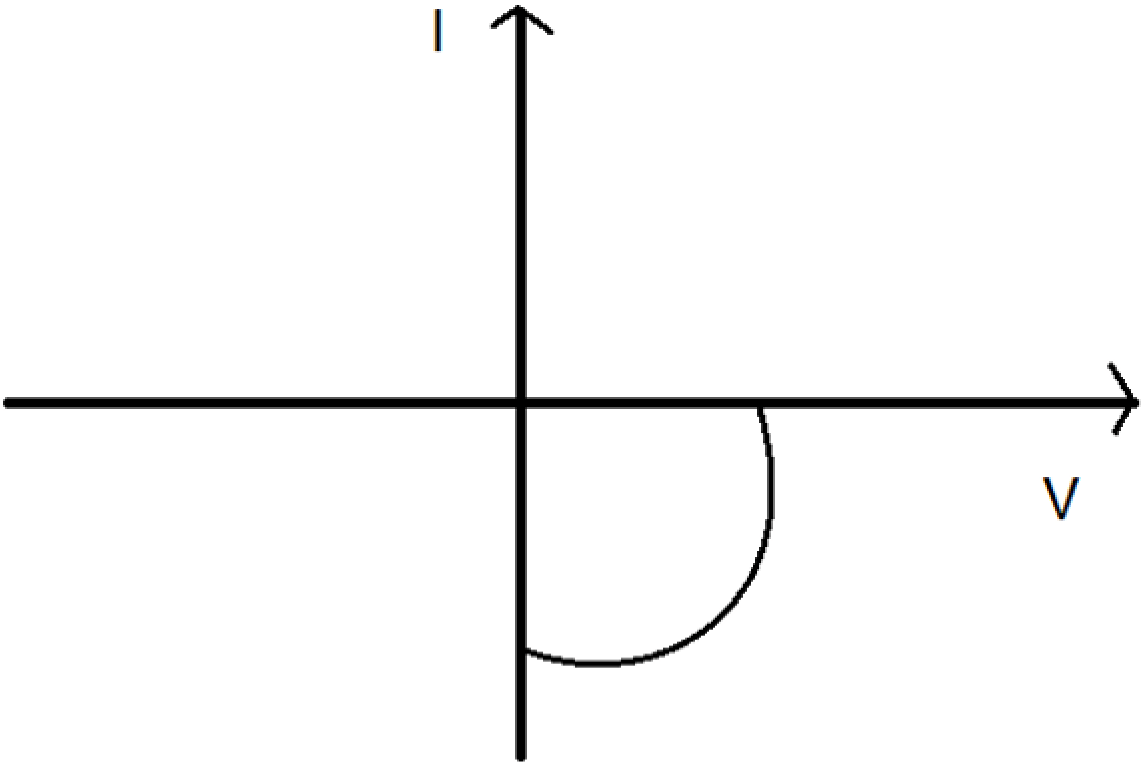
3. The concentration of doping is kept below ______________
a) 1 %
b) 5 %
c) 10 %
d) 50 %
View Answer
Answer: a
Explanation: The concentration of doping in semiconductors is generally kept below 1 %. However, it is enough to bring a huge drop in the energy gap.

4. In N-Type semiconductors, which extra energy level is added?
a) Conduction level
b) Donor Energy Level
c) Acceptor energy level
d) Valence level
View Answer
Answer: b
Explanation: In N-Type semiconductor level, a new energy level below the conduction band is formed. The energy difference between the two is about 0.045 eV.

5. Which of the following can be used to create a P-Type Semiconductor?
a) P
b) Sb
c) Ga

d) As
View Answer
Answer: c
Explanation: For a P-Type semiconductor, a material with 3 valence electrons is chosen. Out of the given choices, Ga can be used to create a P-Type Semiconductor.

6. The following graph depicts the I-V characteristics of which instrument?



a) Photodiode
b) Light Emitting Diode
c) Solar Cell
d) Zener diode
View Answer
Answer: c
Explanation: The generation of EMF by a solar cell is due to three basic processes: generation of electron-hole pair, separation of electrons and holes and collection of electrons by the front contact.
The p-side becomes positive and the n-side becomes negative giving rise to photo voltage.
The I-V characteristics of the solar cell are drawn in the fourth quadrant of the coordinate axis because a solar cell does not draw current but supplies the same to the load.

7. The Hall coefficient of a specimen is 3.66×10^{-4} m^3C^{-1}. If it's resistivity is 8.93×10^{-3} Ωm, what will be its mobility?

a) 0.01 $m^2V^{-1}s^{-1}$
b) 0.02 $m^2V^{-1}s^{-1}$
c) 0.03 $m^2V^{-1}s^{-1}$
d) 0.04 $m^2V^{-1}s^{-1}$
View Answer
Answer: d
Explanation: We know, Mobility = Hall coefficient/resistivity
Therefore, Mobility = 3.66 x 10^{-4}/8.93 x 10^{-3}
= 0.04 $m^2V^{-1}s^{-1}$.

8. Which one of the following is not an intrinsic semiconductor?
a) Carbon
b) Silicon
c) Germanium
d) Lead
View Answer
Answer: a
Explanation: There are 4 bonding electrons in all the above materials. However, the energy required to take out an electron will be maximum for carbon as the valence electrons are in the second orbit. Hence, the number of free electrons for conduction is negligibly small in C.

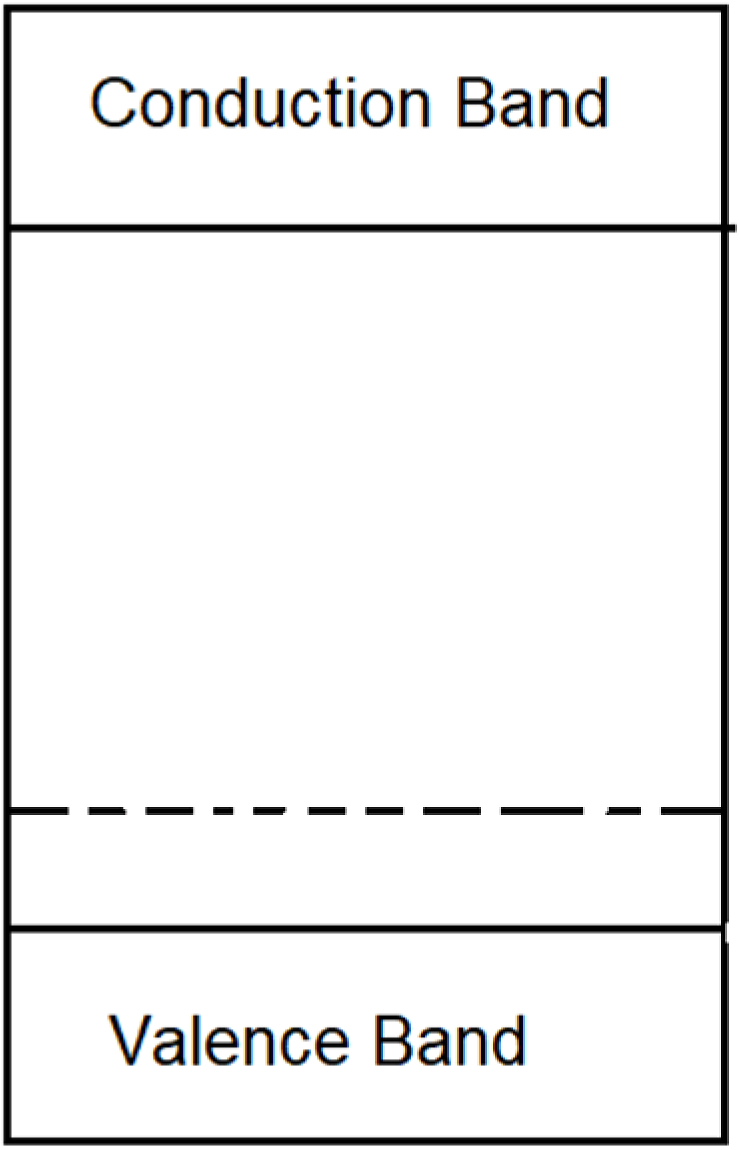
9. Which of the following is n-type semiconductor?
a) CaO
b) MgO
c) ZnO
d) BaO
View Answer
Answer: c
Explanation: II-VI semiconductors are generally p-type semiconductors except for ZnO and ZnTe. II-VI semiconductors are those which contain atoms of materials that have 2 valence electrons and 6 valence electrons.

10. P-Type semiconductor has a lower electrical conductivity than N-Type semiconductor.
a) True
b) False
View Answer
Answer: a
Explanation: Due to comparatively lower mobility of holes than electrons for the same level of doing as in an N-Type semiconductor, it has lower electrical conductivity.

11. Pure Si at 300 K has equal electron (ni) and hole concentration (p) of 1.5 X 10^{16} m^{-3}. Doping by indium increases p to 4.5 X 10^{22} m^{-3}. What is n in the doped silicon?
a) 4.5 X 10^{9} m^{-3}

b) $4.5 \times 10^{22}\ m^{-3}$
c) $5 \times 10^{9}\ m^{-3}$
d)$5 \times 10^{22}\ m^{-3}$
View Answer
Answer: c
Explanation: Here, $n_i = 1.5 \times 10^{16}\ m^{-3}$, $p = 4.5 \times 10^{22}\ m^{-3}$
We know, $np = n_i^2$
$n = n_i^2/p$
$= 5 \times 10^{9}\ m^{-3}$.

12. Identify the type of material.



a) Intrinsic Semiconductor
b) N-Type semiconductor
c) P-Type semiconductor
d) Conductor
View Answer

Answer: c
Explanation: In the figure, as we can see there is an acceptor energy level just above the valence band. This happens in the case of P-Type semiconductors.

13. In a semiconductor it is observed that three-quarters of the current is carried by electrons and one quarters by holes. If the drift speed is three times that of the holes, what is the ratio of electrons to holes?
a) 1 : 1
b) 1 : 2
c) 2 : 1
d) 4 : 1
View Answer
Answer: a
Explanation: In a semiconductor, $I = I_e + I_h$
Here, $I_e = \frac{3}{4} I$ and $I_h = \frac{1}{4} I$
Now $v_e = 3v_h$
$I_e/I_h = nv_e/nv_h$
3 = 3n/p
n = p
Hence the ration is, 1 : 1

14. Holes are the majority carries in Intrinsic Semiconductors.
a) True
b) False
View Answer
Answer: b
Explanation: A pure semiconductor is called an intrinsic semiconductor. Hence, in this case, the number of electrons and holes are same, as the electron that moves out of its position leaves a hole behind. Hence, the concentration of holes and electrons is the same in an intrinsic semiconductor.

15. If the number of electrons (majority carrier) in a semiconductor is 5×10^{20} m^{-3} and μ_e is 0.135 mho, find the resistivity of the semiconductor.
a) 0.0926 Ωm
b) 0.0945 Ωm
c) 0.0912 Ωm
d) 0.0978 Ωm
View Answer
Answer: a
Explanation: We know, Conductivity, $\sigma = en_e \mu_e$
= 5 X 1.6 X 0.135 X 10 mho/m
= 10.8 mho/m
Resistivity = 1/σ
= 0.0926 Ωm.

"Solar Cell".

1. A solar cell is a ___________
a) P-type semiconductor
b) N-type semiconductor
c) Intrinsic semiconductor
d) P-N Junction
View Answer
Answer: d
Explanation: A p-n junction which generated EMF when solar radiation is incident on it is called a solar cell. The material used for fabrication of solar cell should have a band gap of around 1.5 eV.

2. Which of the following materials cannot be used as solar cells materials?
a) Si
b) GaAs
c) CdS
d) PbS
View Answer
Answer: d
Explanation: If we use PbS as the solar cell material, then most of the solar radiation will be absorbed on the top-layer of the solar cell and will not reach in the depletion zone.

3. The principle of a solar cell is same as the photodiode.
a) True
b) False
View Answer
Answer: a
Explanation: The solar cell works on the same principle as the photodiode, except that no external bias is applied and the junction area is kept much larger.

4. What is the difference between Photodiode and Solar cell?
a) No External Bias in Photodiode
b) No External Bias in Solar cell
c) Larger surface area in photodiode
d) No difference
View Answer
Answer: b
Explanation: The Solar Cell does not need an external bias. It simply works on the incident solar radiation, which causes the creation of electron hole pairs.

5. During the collection of e-h pairs, holes are collected by _________
a) Front contact
b) Back contact

c) Si-wafer
d) Finger electrodes
View Answer
Answer: b
Explanation: As the electron-hole pairs move, the electrons are collected by the front contact and the holes reaching p-side are collected by the back contact.

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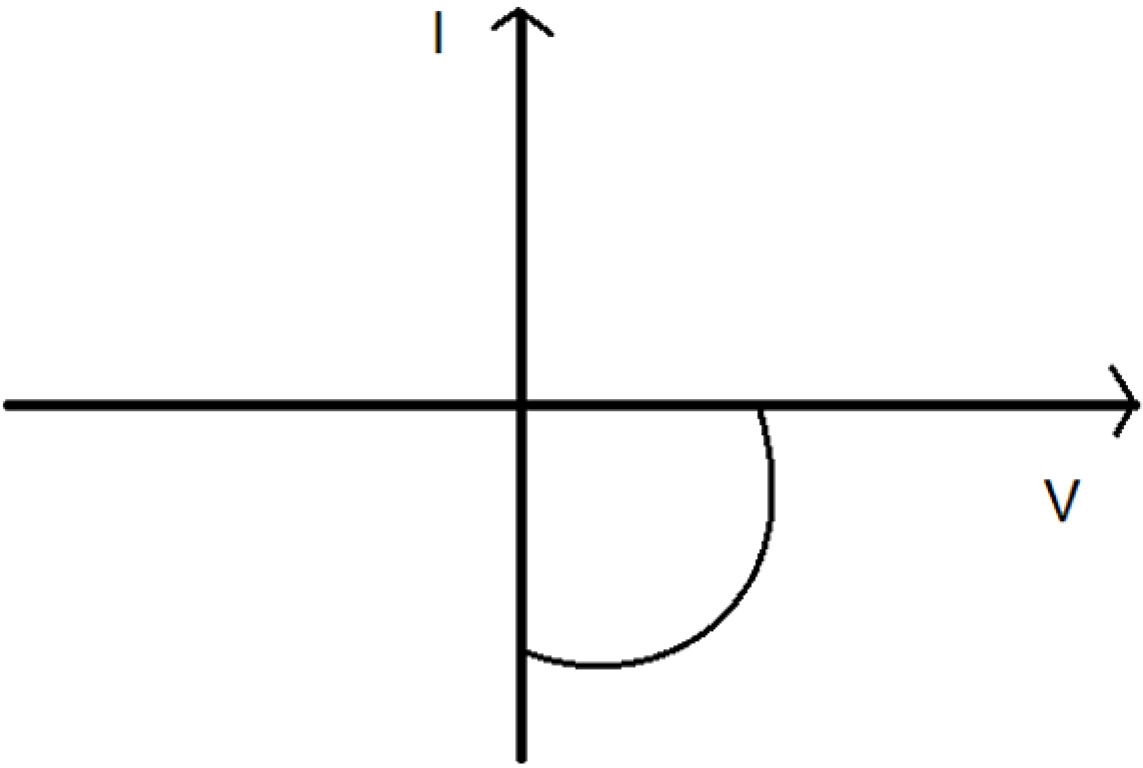
6. What is the point where the graph touches the X-axis Indicate?



a) Voltage Breakdown
b) RMS Voltage
c) Open Circuit Voltage
d) Short Circuit Voltage
View Answer
Answer: c
Explanation: In the given figure, the point where the graph touches the X-axis shows the open circuit voltage while the point where it touches the Y-axis shows the short circuit current.

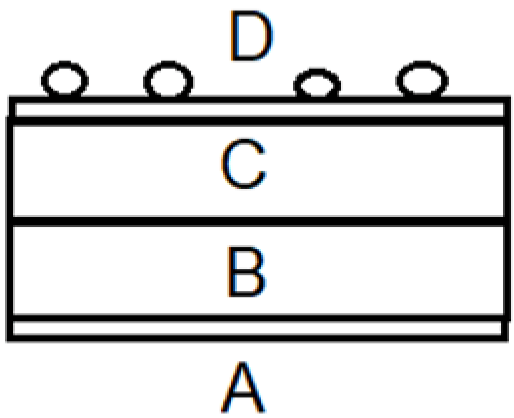
7. The I-V characteristics of a solar cell are drawn in the fourth quadrant.
a) True
b) False
View Answer

Answer: a
Explanation: The I-V characteristics of a solar cell is drawn in the fourth quadrant of the coordinate axis because a solar cell does not draw current but supplies the same to the load.

8. What should be the band gap of the semiconductors to be used as solar cell materials?
a) 0.5 eV
b) 1 eV
c) 1.5 eV
d) 1.9 eV
View Answer
Answer: c
Explanation: Semiconductors with band gap close to 1.5 eV are ideal materials for solar cell fabrication. They are made with semiconductors like Si, GaAs, CdTe, etc.

9. Which of the following should not be the characteristic of the solar cell material?
a) High Absorption
b) High Conductivity
c) High Energy Band
d) High Availability
View Answer
Answer: c
Explanation: The Energy Band of the semiconductor should not be too high. It should be around 1.5 eV so that the incident solar radiation can cause the generation of e-h pairs.

10. Which of the following region is coated with a metal?



a) A
b) B
c) C
d) D
View Answer
Answer: a
Explanation: In the given figure, A is the back contact which is coated with a metal, B

is the p-Si wafer, C is the n-Si wafer and D is the front contact which has metallized finger electrodes.

"Characteristics of P-N Junction".

1. In a P-N Junction, the depletion region is reduced when _________
a) P side is connected to the negative side of the terminal
b) P side is connected to the positive side of the terminal
c) N side is connected to the positive side of the terminal
d) Never reduced
View Answer
Answer: b
Explanation: When the P-side of a P-N junction is connected to the positive terminal of a battery, the junction is forward biased and hence the depletion region reduces.

2. The voltage at which forward bias current increases rapidly is called as ___________
a) Breakdown Voltage
b) Forward Voltage
c) Knee Voltage
d) Voltage barrier
View Answer
Answer: c
Explanation: Till the knee voltage, the current in a semiconductor increases slowly. After Knee voltage, the current increases rapidly for a small change in the voltage.

3. The Knee Voltage for germanium is _________
a) 0.1 V
b) 0.3 V
c) 0.7 V
d) 1.4 V
View Answer
Answer: b
Explanation: Knee voltage or the threshold voltage is the point after which the current increases rapidly. For germanium, it is about 0.3 V while for silicon it is 0.7 V.

4. The resistance of the semiconductor decreases in forward biased.
a) True
b) False
View Answer
Answer: a
Explanation: When a P-N Junction diode is forward biased, the thickness of the

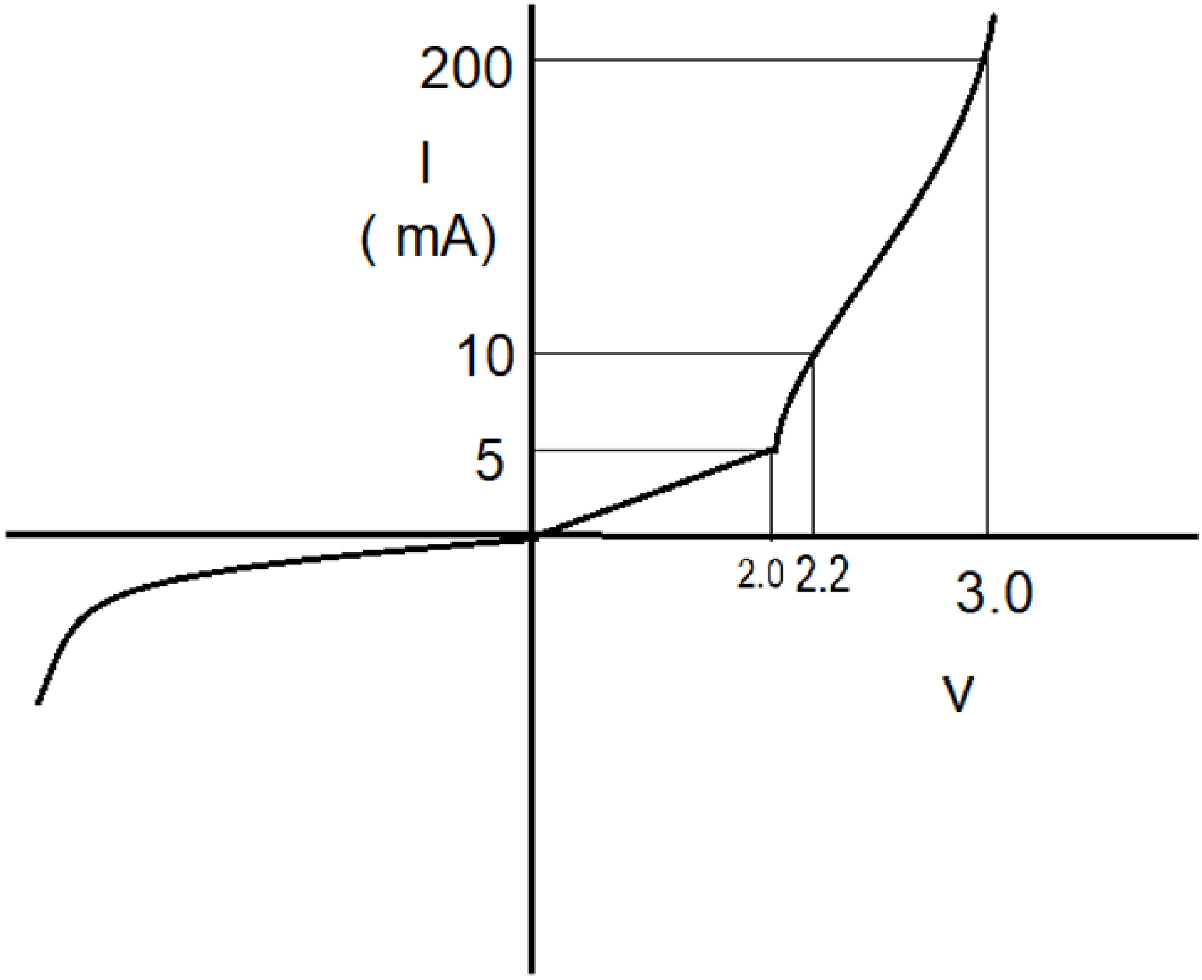
depletion region becomes negligibly small. Thus, the resistance of the semiconductor decreases.

5. The current produced in reverse-bias is called as __________
a) Reverse Current
b) Breakdown Current
c) Negative Current
d) Leakage Current
View Answer
Answer: d
Explanation: When the diode is reverse biased, the reverse bias voltage produces an extremely small current, about a few micro amperes. This is called leakage current.

6. Which diode is designed to work under breakdown region?
a) Photodiode
b) Light Emitting Diode
c) Solar Cell
d) Zener diode
View Answer
Answer: d
Explanation: Zener Diode is designed specifically to operate in the breakdown region. It is mostly used as a voltage regulator in various circuits.

7. The P-N junction is a non-ohmic device.
a) True
b) False
View Answer
Answer: a
Explanation: The current-voltage curve of a P-N junction diode is not a straight line. Thus, it does not obey Ohm's law and is a non-ohmic device.

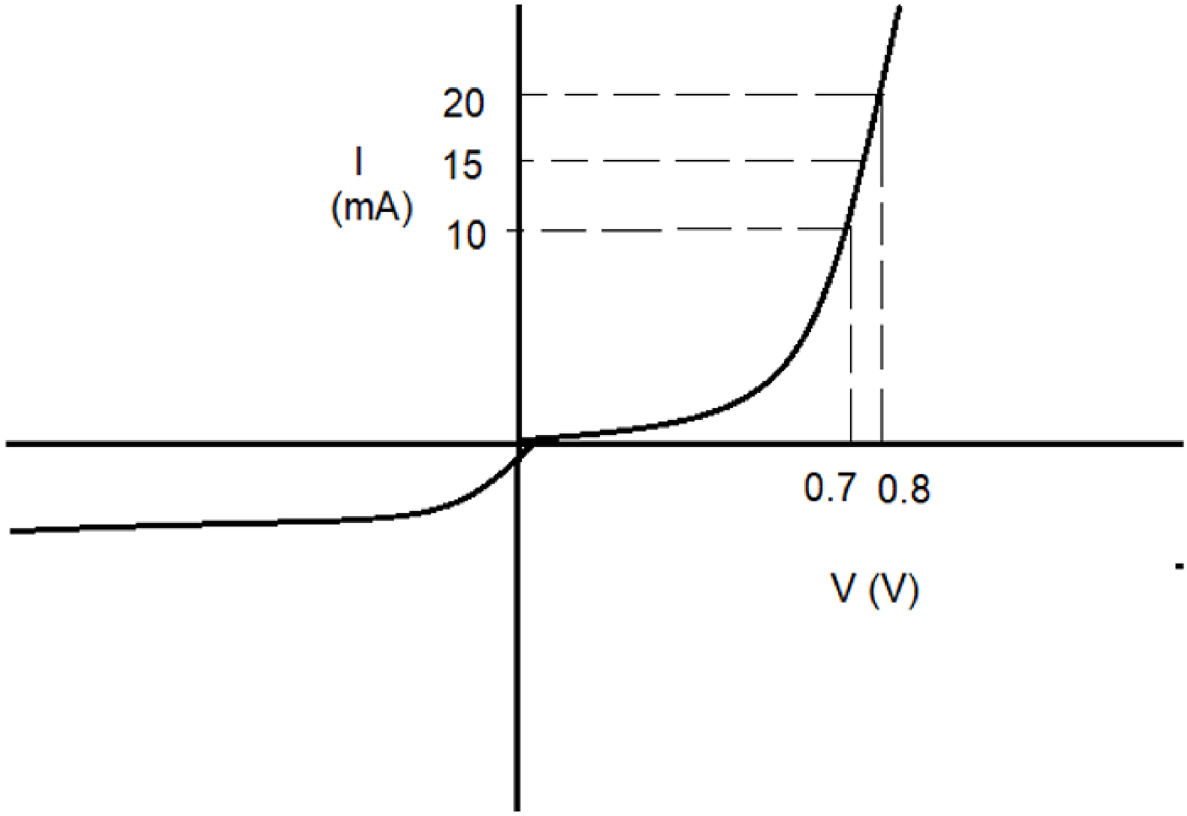
8. The I-V characteristics of a p-n junction diode is shown. What is the resistance of the junction when a forward bias of 2 V is applied?



a) 20 Ω
b) 40 Ω
c) 60 Ω
d) 80 Ω
View Answer
Answer: b
Explanation: The current at 2 V is 5 mA and at 2.2 V it is 10 mA.
The dynamic resistance is: Δ V/Δ I
= $0.5/5 \times 10^3$ Ω
= 40 Ω.

9. The leakage current is measured in ________
a) A
b) mA
c) μA
d) nA
View Answer
Answer: c
Explanation: As in the reverse current, the resistance increases, the current produced is extremely low. And hence, it is measured in microamperes.

10. From the I-V characteristics, calculate the resistance of the diode at I = 15 mA.



a) 10 Ω
b) 12 Ω
c) 14 Ω
d) 15 Ω
View Answer
Answer: a
Explanation: From the curve, I = 20 mA, V = 0.8 V, I = 10 mA when V = 0.7 V
Now, R = Δ V/Δ I
= 0.1 V/10 mA
= 10 Ω.

"Zenner Diode".

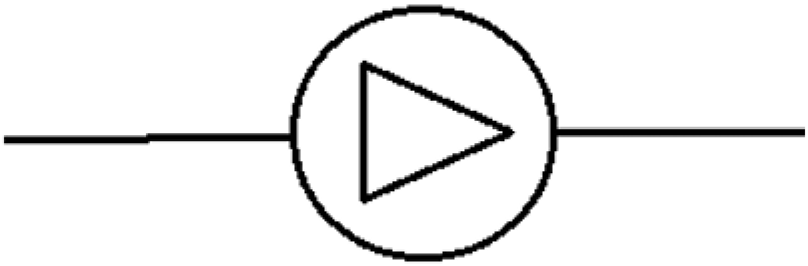
1. Zener diode is designed to specifically work in which region without getting damaged?
a) Active region
b) Breakdown region
c) Forward bias
d) Reverse bias
View Answer
Answer: b
Explanation: The Zener diode is a specifically designed diode to operate in the breakdown region without getting damaged. Because of this characteristic, it can be used as a constant-voltage device.

2. What is the level of doping in Zener Diode?
a) Lightly Doped
b) Heavily Doped
c) Moderately Doped
d) No doping
View Answer
Answer: b
Explanation: A Zener diode is heavily doped so that the breakdown voltage occurs at a lower voltage. If it were lightly/moderately doped, it would breakdown at a comparatively high voltage and, thus, would not be able to serve its purpose.

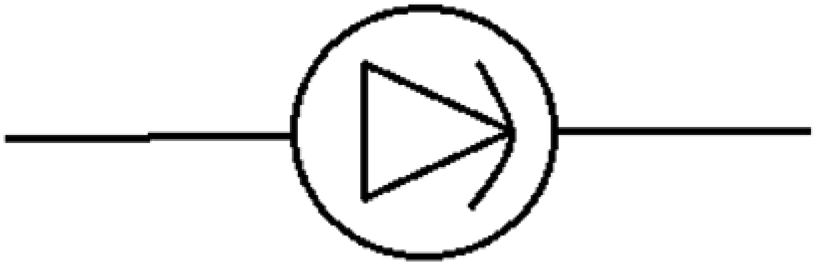
3. When the reverse voltage across the Zener diode is increased ____________
a) The value of saturation current increases
b) No effect
c) The value of cut-off potential increases
d) The value of cut-off potential decreases
View Answer
Answer: c
Explanation: As the frequency of the incident radiation increases, the kinetic energies of the emitted electron are higher and therefore require more repulsive force to be applied to stop them.
The value of saturation current increases, as the intensity of the incident radiation, increases.
The value of cut-off potential decreases, as the frequency decreases.

4. Zener Diode is mostly used as ___________
a) Half-wave rectifier
b) Full-wave rectifier
c) Voltage Regulator
d) LED
View Answer
Answer: c
Explanation: The Zener diode, once in the breakdown region, keeps the voltage in the circuit to which it is connected as constant. Thus it is widely used as a voltage regulator.

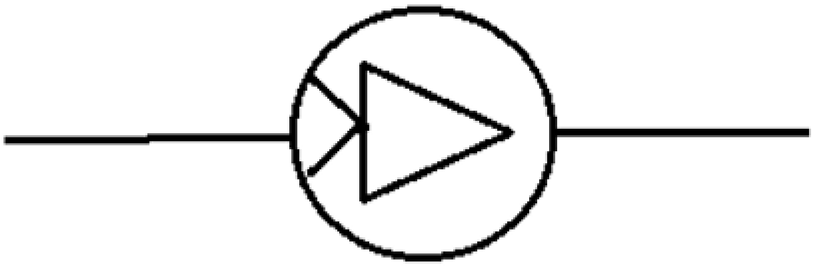
5. Which of the following is the correct symbol for the zener diode?



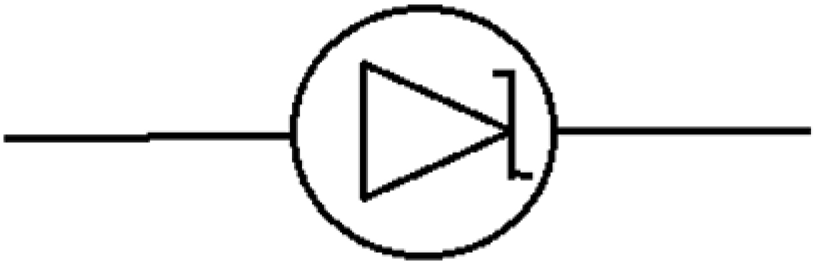
a)



b)



c)

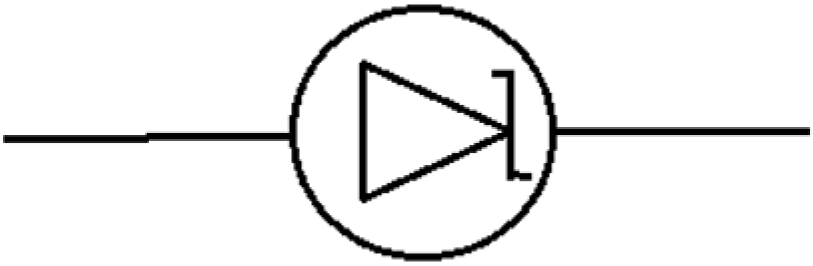


d)

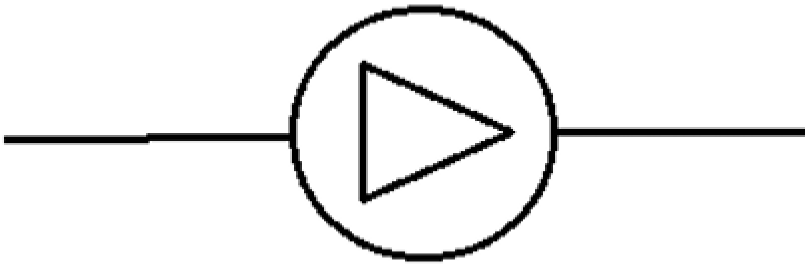
View Answer

Answer: d

Explanation: The following figure is the correct symbol for the Zener diode.



The following figure is the symbol of a normal p-n junction diode.



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6. In normal junctions, the breakdown is same as Zener breakdown.
a) True
b) False
View Answer
Answer: b
Explanation: In normal p-n unction diodes, the breakdown takes place by avalanche breakdown which is different than the Zener breakdown. Zener diode is specifically made to operate in that region.

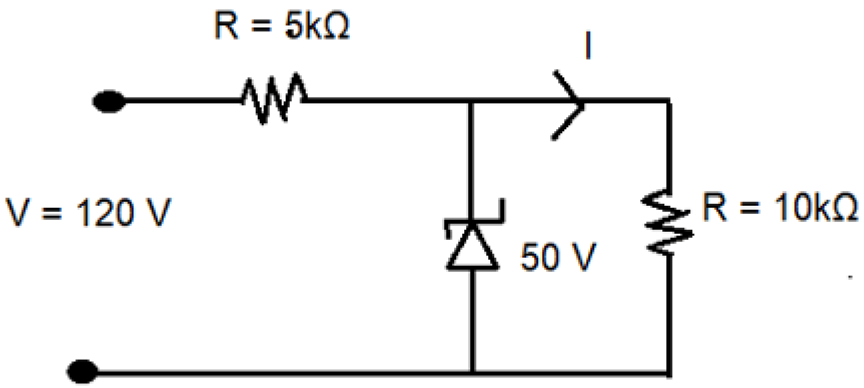
7. The depletion region of the Zener diode is ___________
a) Thick
b) Normal
c) Very Thin
d) Very thick
View Answer
Answer: c
Explanation: Zener diode is fabricated by heavily doping both p- and n-sides of the junction, which results in an extremely thin depletion region.

8. The electric field required for the field ionization is of what order?
a) 10^4 V/m
b) 10^5 V/m
c) 10^6 V/m
d) 10^7 V/m
View Answer
Answer: c
Explanation: In a Zener diode, a very high electric field is produced for even a very small voltage. The electric field required for field ionization is of the order 10^6 V/m.

9. In a circuit the load current is 5 mA and the unregulated output is 10 V. If the voltage drop across the Zener diode is 3 V, what should be the value of resistance?
a) 50 Ω
b) 100 Ω
c) 125 Ω

d) 150 Ω
View Answer
Answer: d
Explanation: The value of R should be such that the current through the Zener diode is much larger than the load current.
Imagine, I_z = 20 mA. The total current is therefore 24 mA.
The voltage drop = 3 V
Resistance = 3 V/24 X 10^{-3} A
Resistance = 125 Ω.

10. In the circuit, what is the output voltage?



a) 50 V
b) 70 V
c) 120 V
d) 170 V
View Answer
Answer: a
Explanation: In the absence of Zener diode, the open circuit voltage, V = $R_l V_i$/ R + R_l
V = 80 V
Now, since the breakdown voltage of the Zener diode is 50 V, the diode will undergo breakdown
Output Voltage would be equal to 50 V.

"LED".

1. A light emitting diode is ________
a) Heavily doped
b) Lightly doped
c) Intrinsic semiconductor
d) Zener diode
View Answer
Answer: a
Explanation: A light emitting diode, LED, is heavily doped. It works under forward biased conditions. When the electrons recombine with holes, the energy released in the form of photons causes the production of light.

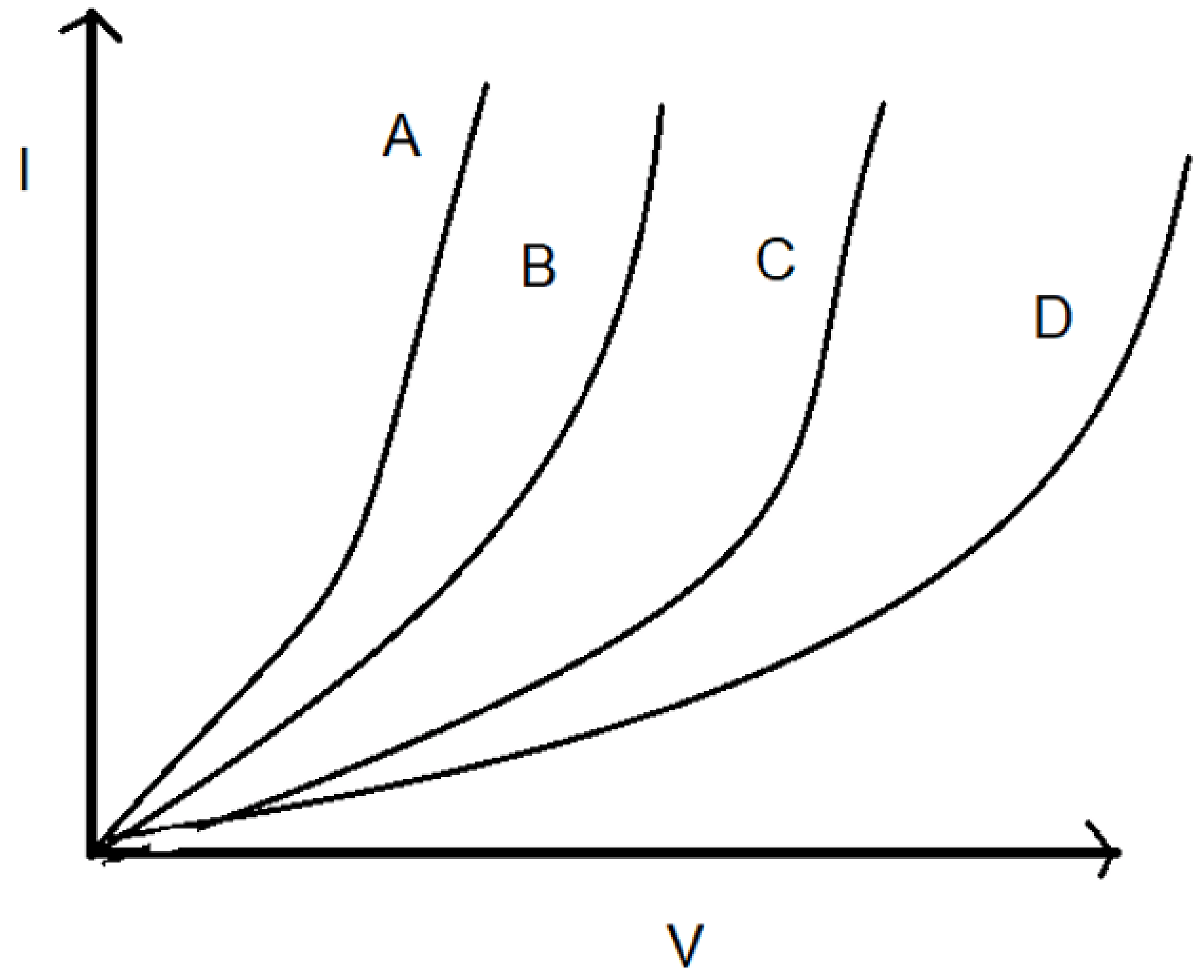
2. Which of the following materials can be used to produce infrared LED?
a) Si
b) GaAs
c) CdS
d) PbS
View Answer
Answer: b
Explanation: GaAs has an energy band gap of 1.4 eV. It can be used to produce infrared LED. Various other combinations can be used to produce LED of different colors.

3. The reverse breakdown voltage of LED is very low.
a) True
b) False
View Answer
Answer: a
Explanation: The reverse breakdown voltages of LEDs are very low, typically around 5 V. So, if access voltage is provided, they will get fused.

4. What should be the band gap of the semiconductors to be used as LED?
a) 0.5 eV
b) 1 eV
c) 1.5 eV
d) 1.8 eV
View Answer
Answer: d
Explanation: Semiconductors with band gap close to 1.8 eV are ideal materials for LED. They are made with semiconductors like GaAs, GaAsP etc.

5. What should be the biasing of the LED?
a) Forward bias
b) Reverse bias
c) Forward bias than Reverse bias
d) No biasing required
View Answer
Answer: a
Explanation: The LED works when the p-n junction is forward biased i.e., the p- side is connected to the positive terminal and n-side to the negative terminal.

6. Which of the following would have highest wavelength?



a) A
b) B
c) C
d) D
View Answer
Answer: a
Explanation: In the I-V characteristic of an LED, as the frequency increases, the voltage required to achieve the same current increases. Hence A would have the highest wavelength.

7. Increase in the forward current always increases the intensity of an LED.
a) True
b) False
View Answer
Answer: b
Explanation: As the forward current is increased for an LED, the intensity of the light increases up to a certain maximum value. After that, the intensity starts decreasing.

8. Which process of the Electron-hole pair is responsible for emitting of light?
a) Generation

b) Movement
c) Recombination
d) Diffusion
View Answer
Answer: c
Explanation: When the recombination of electrons with holes takes place, the energy is released in the form of photon. This photon is responsible for the emission of light.

9. What is the bandwidth of the emitted light in an LED?
a) 1 nm to 10 nm
b) 10 nm to 50 nm
c) 50 nm to 100 nm
d) 100 nm to 500 nm
View Answer
Answer: b
Explanation: The bandwidth of the emitted light is 10 nm to 50 nm. Thus, the emitted light is nearly (but not exactly) monochromatic.

10. Which of the following is not a characteristic of LED?
a) Fast action
b) High Warm-up time
c) Low operational voltage
d) Long life
View Answer
Answer: b
Explanation: The warm-up time required should be lower so that the lighting action can take place faster. This is one of the advantages LED have over incandescent lamps.

"Transistors".

1. BJT stands for __________
a) Bi-Junction Transfer
b) Blue Junction Transistor
c) Bipolar Junction Transistor
d) Base Junction Transistor
View Answer
Answer: c
Explanation: BJT stands for Bipolar Junction Transistor. It was the first transistor to be invented. It is widely used in circuits.

2. The doped region in a transistor are ________
a) Emitter and Collector
b) Emitter and Base

c) Collector and Base
d) Emitter, Collector and Base
View Answer
Answer: d
Explanation: There are three doped regions forming two p-n junctions between them. There are two types of transistors n-p-n transistor and p-n-p transistor.

3. Which region of the transistor is highly doped?
a) Emitter
b) Base
c) Collector
d) Both Emitter and Collector
View Answer
Answer: a
Explanation: In a transistor, emitter is of moderate size and heavily doped. Collector is moderately doped and larger as compared to the emitter. Base is very thin and lightly doped.

4. Both the junctions in a transistor are forward biased.
a) True
b) False
View Answer
Answer: b
Explanation: Emitter-base junction of the transistor is forwards biased while the collector-base junction of the transistor is reverse biased or vice versa depending on the condition desired.

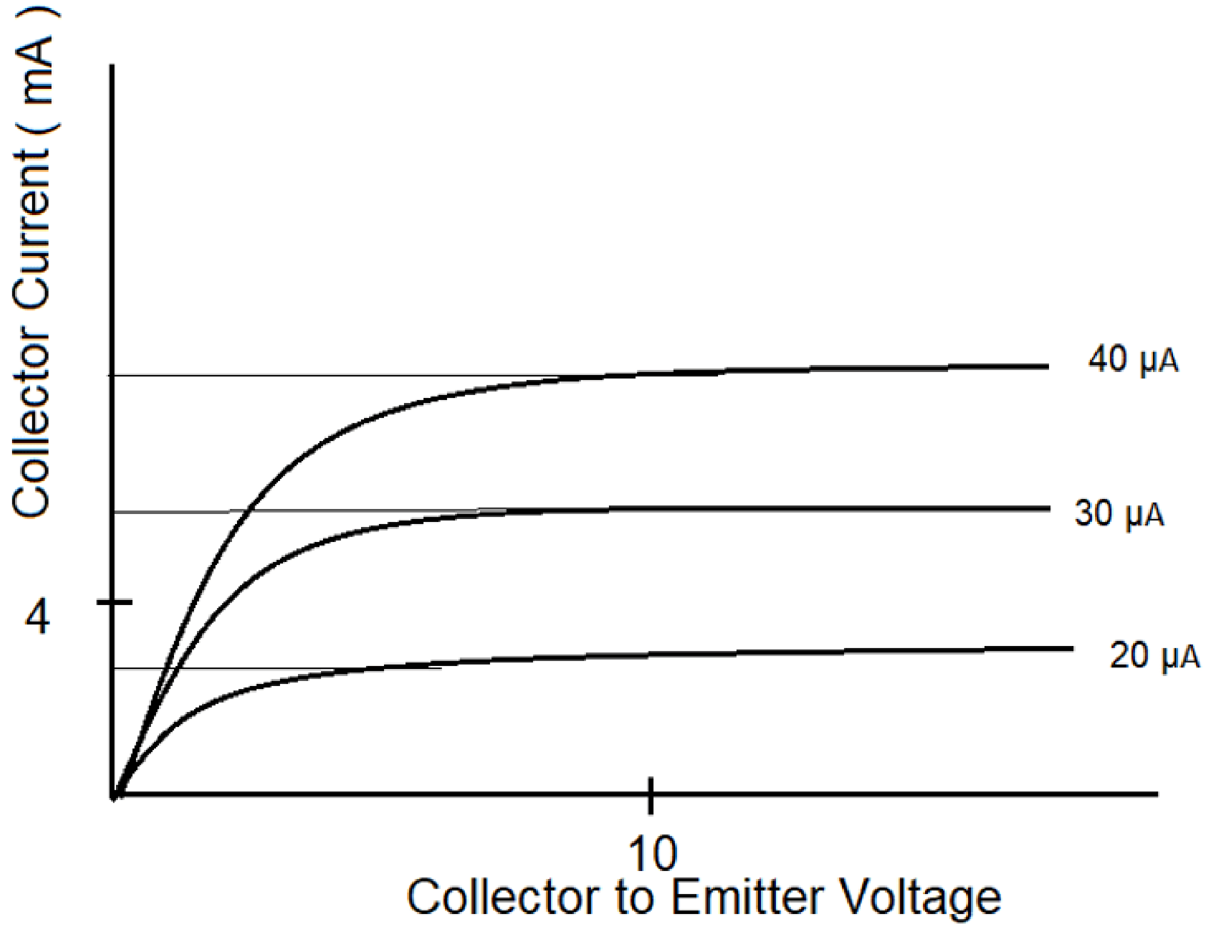
5. Which junction is forward biased when transistor is used as an amplifier?
a) Emitter-Base
b) Emitter-Collector
c) Collector-Base
d) No junction is forward biased
View Answer
Answer: a
Explanation: For Transistor to be used as an amplifier, the emitter-base junction is forward biased and the base-collector region is reverse biased. This state is called an active state.

6. If I_e is the current entering the emitter, I_b is the current leaving the base and I_c is the current leaving the collector in a p-n-p transistor used for amplification, what is the relation between I_e, I_b and I_c?

a) $I_e < I_c$
b) $I_c < I_b$
c) $I_b < I_c$
d) $I_e < I_b + I_c$
View Answer
Answer: c
Explanation: The total current entering the emitter, I_e, goes to the base form where most of the current enters the collector and a very small fraction of the current leaves the base. Thus, $I_b < I_c$.

7. In the active state, the emitter-base junction has a higher resistance than the collector-base junction.
a) True
b) False
View Answer
Answer: b
Explanation: Since the emitter-base junction is forward biased, their resistance is lower than the collector-base junction, which is reverse biased.

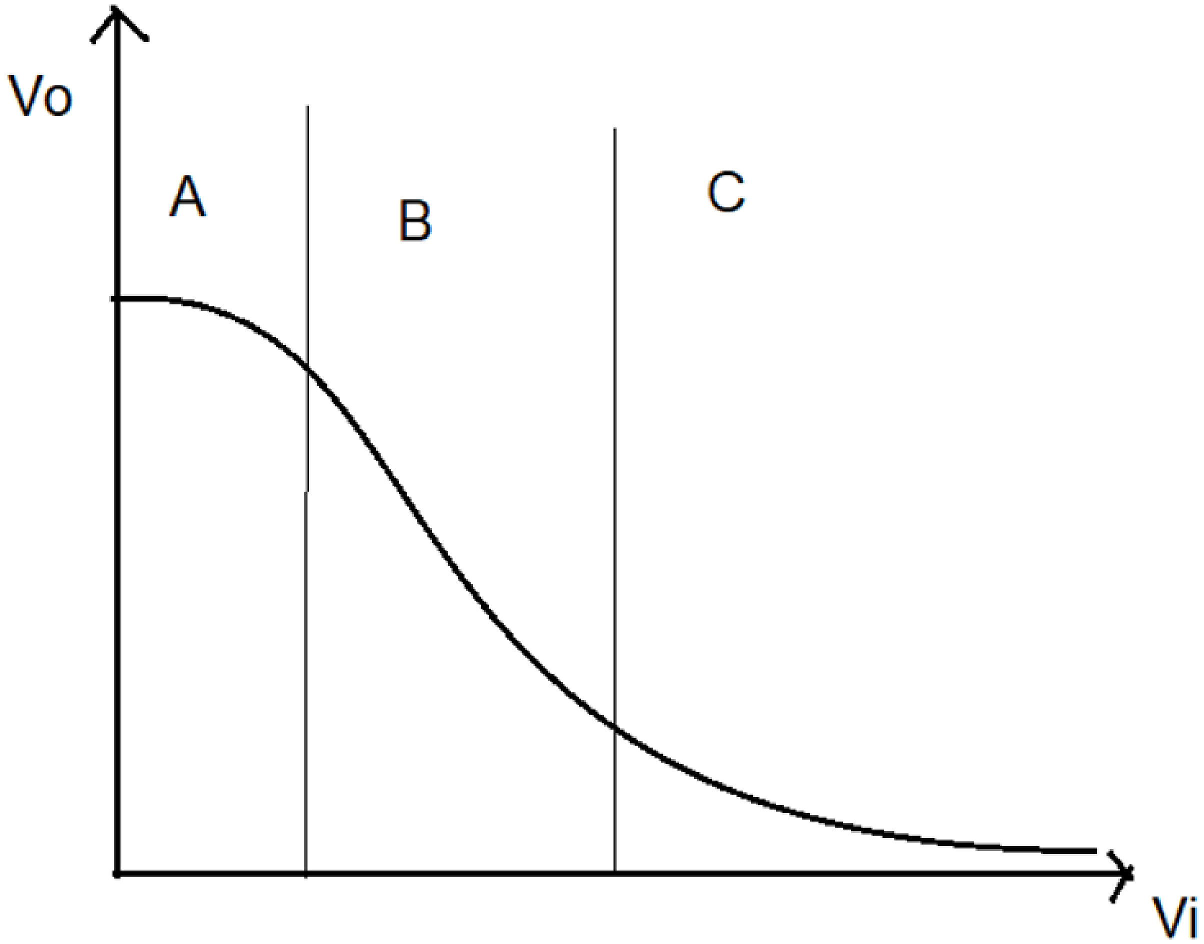
8. From the figure, what is β_{ac} when V_{CE} is 10V and I_c is 4 mA?



a) 50
b) 100

c) 150
d) 200
View Answer
Answer: c
Explanation: We know, $\beta_{ac} = \Delta I_c/\Delta I_b$
Now, at V_{CE} = 10V, we read two values of I_c from the graph.
Then, ΔI_b = 10 μA, ΔI_c = 1.5 mA
Therefore, β_{ac} = 1.5 mA/10 μA
= 150.

9. In which state is the switch said to be on?



a) A
b) B
c) C
d) Neither region
View Answer
Answer: c
Explanation: A is the Cut-off region, B is the Active Region and C is the saturation region. When the transistor is not conducting, it is said to be switched off and when it is Region C it is said to be switched on.

10. A low input to the transistor gives __________
a) Low output
b) High Output
c) Normal Output
d) No Output
View Answer
Answer: b
Explanation: A low input to the transistor gives a high output and a high input gives a low output. The switching circuits are designed such a way that the transistor does not stay in the active state.

11. In a CE transmitter amplifier, if the amplification factor is 150 and the collector voltage is 4 V and resistance is 2 kΩ, what should be the value of RB, given that the dc base current is 10 times the signal current?
a) 5 kΩ
b) 10 kΩ
c) 15 kΩ
d) 20 kΩ
View Answer
Answer: d
Explanation: Here, the output voltage is 4 V.
So, i_c = 4/2000
= 2 mA
The signal current through the base, $I_B = i_c/\beta$
= 0.013 mA
The dc base current = 0.13 mA
Assuming here, that V_{BE} = 1.4 V, we get
R_B = (4.0-1.4)/0.13
= 20 kΩ.

12. From the output characteristics of a transistor, one cannot calculate __________
a) I_B
b) V_{BE}
c) I_c
d) V_{CE}
View Answer
Answer: b
Explanation: The output characteristics graph for a transistor gives us the relation between the collector current and the emitter voltage. It also gives us the value of base current. But it gives no information about the base-emitter voltage.

13. What is the expression for the Current Amplification factor?
a) $\Delta I_c \Delta V_c$
b) $\Delta V_c \Delta I_c$
c) $\left(\Delta I_C \Delta I_B\right)_{V_{CE}}$

d) $\left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{BE}}$
View Answer
Answer: c
Explanation: Amplification factor can be defined as the ratio of the change in collector current to the change in base current at a constant collector-emitter voltage when the transistor is in active state. The correct expression for the amplification factor is: $\left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$.

14. In the output characteristics, the resistance is the __________
a) Slope of the curve
b) Trace of the curve
c) Asymptote of the curve
d) Reciprocal of the slope of the curve
View Answer
Answer: d
Explanation: The reciprocal of the slope of the linear part of the output characteristic gives the value of the output resistance, which is given by $\left(\frac{\Delta V_{CE}}{\Delta I_C}\right)_{I_B}$.

15. The output in an oscillator is __________
a) Discontinuous
b) Oscillating
c) Self-sustained
d) Spiked
View Answer
Answer: c
Explanation: In an oscillator, we get ac output without any external input signal. Thus, the output in an oscillator is self-sustained. To attain this, an amplifier is taken, which uses a transistor.

"Diode as a Rectifier".

1. If a rectifier has 2 diodes it is a __________
a) Quarter-wave rectifier
b) Half-wave rectifier
c) Full-wave rectifier
d) Peak-to-peak rectifier
View Answer
Answer: c
Explanation: A full-wave rectifier requires at least 2 diodes. If only one junction diode is used, then the wave would be only half rectified. The two diodes are connected in such a way, that when one diode is forward biased the other would be reverse biased.

2. How does the frequency of the wave changes when the wave has been half-rectified?

a) Doubles
b) Halves
c) One-fourth
d) Remains same
View Answer
Answer: d
Explanation: After the wave has been half-rectified, the frequency of the wave remains same. When the wave has been fully rectified, then the frequency doubles.

3. In a full-wave rectifier, at a certain point of time, what is the biasing of both the diodes?
a) When one is Forward biased, other is Reverse biased
b) Both forward biased
c) Both reverse biased
d) Can't be predicted
View Answer
Answer: a
Explanation: In the case of a full-wave rectifier, the two diodes are connected such that when one diode is forward biased, the other one would be reverse biased.

4. After rectifying the wave, the output voltage does not vary.
a) True
b) False
View Answer
Answer: b
Explanation: After a wave has been rectified, the output voltage, though still varying, is restricted to only one direction. The frequency of the wave remains the same.

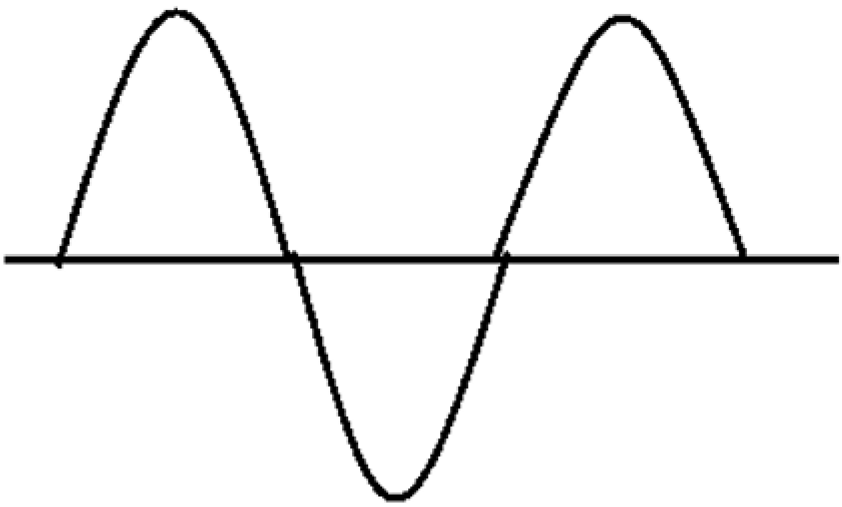
5. Which device is used to get a steady DC output?
a) Battery
b) Zener Diode
c) Resistor
d) Capacitor
View Answer
Answer: d
Explanation: Though the rectified voltage is unidirectional, it does not have a steady value. To get steady DC output from the pulsating voltage normally a capacitor is connected across the output.

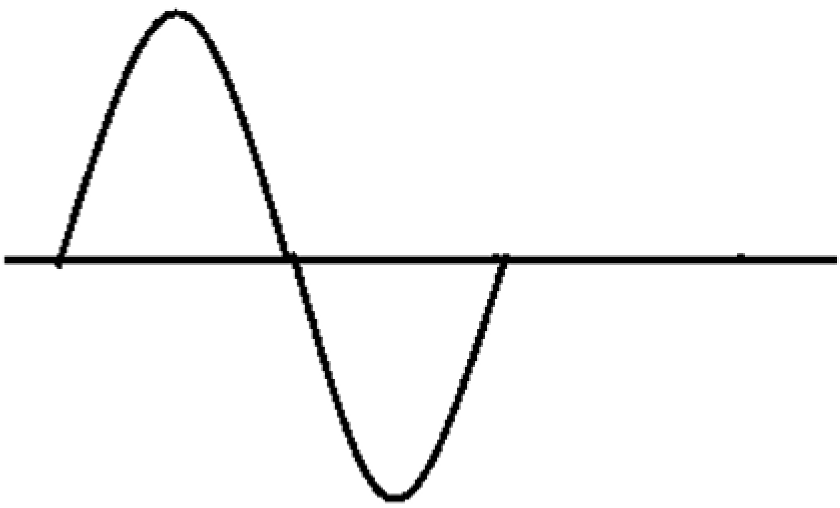
6. Which of the following is not a use of Rectifier Diode?
a) Voltage Reference

b) Detection signals
c) Voltage regulator
d) LASER diodes
View Answer
Answer: c
Explanation: Rectifier diode is used for Voltage reference, detection signals and LASER diodes as well. Zener Diode is used as a voltage regulator.

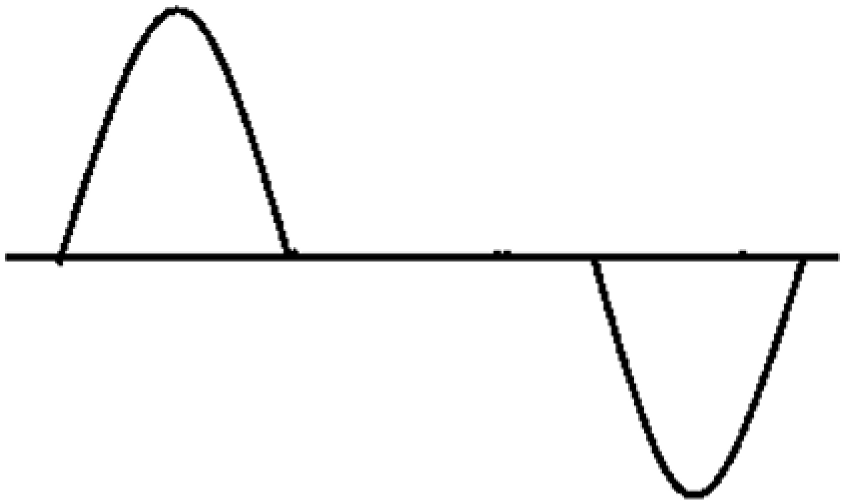
7. The rectifier diode is a non-ohmic device.
a) True
b) False
View Answer
Answer: a
Explanation: The current-voltage curve of a rectifier diode is not a straight line. Thus, it does not obey Ohm’s law and is a non-ohmic device.

8. How would the following wave be half-wave rectified?

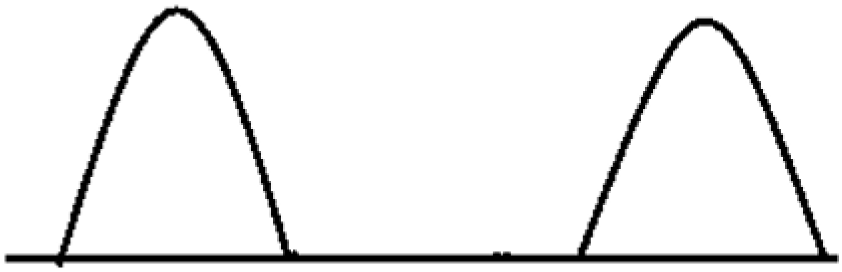




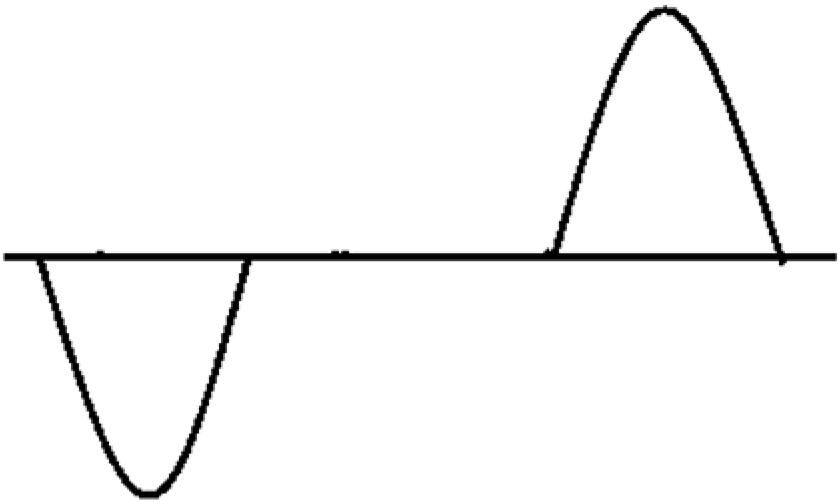
a)



b)



c)

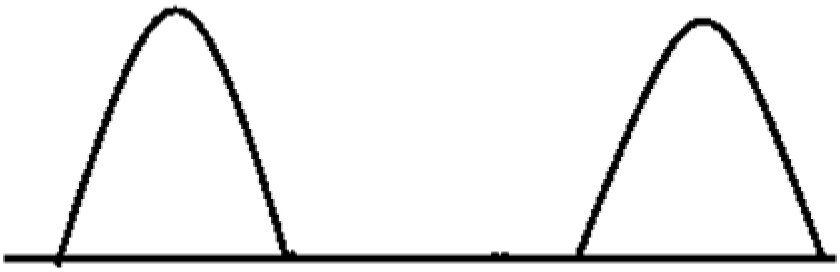


d)

View Answer

Answer: c

Explanation: When the given wave would be fed into a rectifier, all the output would be restricted to only one direction.



9. For high frequency rectifying application, which diode is used?
a) LED
b) Power Diode
c) Zener Diode
d) Schottky Diode
View Answer
Answer: d
Explanation: The voltage in forward bias condition is low in Schottky diodes. Also, it's the reverse recovery time is short. Due to these factors, Schottky diodes are used for high frequency rectifying applications.

10. Which characteristic of Power Diode makes it suitable for rectification of large current devices?
a) Heavily doped
b) Larger Junction
c) Thicker depletion zone
d) Greater charge carriers
View Answer
Answer: b
Explanation: When the forward current is large, small diodes generally get overheated and melt. Thus, to prevent that, Power diode is used as it has a larger P-N junction area, resulting in a high forward current capability and reverse blocking voltage.

"Drift and Diffusion Current".

1. Drift current is due to ___________
a) Applied electric field over a given distance
b) Random motion of electrons
c) Random motion of holes
d) Recombination of holes and electrons
View Answer
Answer: a
Explanation: Drift current is a type of electric current due to the movement of charge carriers which occurs because of applied electric field across the p-n junction often stated as electromotive force over a given distance.

2. Diffusion current is due to ___________
a) Applied electric field over a given distance
b) Variation in carrier concentration
c) Random motion of holes
d) Recombination of holes and electrons
View Answer
Answer: b
Explanation: Diffusion current is due to the actual movement of carrier charges

from one side to another. The direction of diffusion depends on the slope of the carrier concentration that is the gradient of density of carriers.

3. What makes up the total current in a semi-conductor?
a) Only diffusion current
b) Only drift current
c) Drift+diffusion current
d) Drift+diffusion+biasing current
View Answer
Answer: c
Explanation: In an unbiased semi-conductor the drift current is balanced by diffusion current and hence there is no current flowing in the semi-conductor in this condition, but in biased condition both these currents are unbalanced and hence the total current flowing is the vector sum of both drift and diffusion current.

4. Conductors also have drift current.
a) True
b) False
View Answer
Answer: a
Explanation: In good conductors there are many electrons moving freely in the conduction band and thus on application of an electric field these free electrons move whereas in semi-conductors drift current flows because of less number of free electrons.

5. The equation $J_n=qn\mu_nE$ (A/cm^2) represents___________
a) Drift current
b) Drift current density
c) Diffusion current
d) Diffusion current density
View Answer
Answer: b
Explanation: Here 'q' is the charge on carrier, 'n' is the number of carriers, 'μn' is the mobility constant and 'E' is the electric field intensity. These are the factors which comprise the drift current and hence the equation represents the drift current density.

6. Is the statement "Diffusion current produces Drift current" true?
a) Yes
b) No
c) Cannot Say

d) Insufficient Data
View Answer
Answer: a
Explanation: The movement of charge carriers is diffusion current and this movement produces an electric field which is the root cause of drift current. This is also proved by the fact that both drift and diffusion current are equal and opposite in an unbiased semi-conductor.

7. What is the average net velocity in the direction of the electric field?
a) Velocity of electrons
b) Velocity of holes
c) Drift velocity
d) Collision velocity
View Answer
Answer: c
Explanation: The carriers accelerate in the direction of electric field between collisions but for each time interval τc (collision time) there is a collision which randomises the velocity of the carrier. This average net velocity in the direction of electric field is Drift velocity.

8. What is mobility?
a) Ease of carrier drift
b) Ease of current flow
c) Ease of access to the junction
d) Ease of movement
View Answer
Answer: a
Explanation: Mobility is the ease with which carriers can drift. The higher the collision time, the greater is the mobility also the lighter is the carrier, the greater is its mobility. Thus on the application of an electric field it's easier for carriers to drift.

9. Why does a gradient occur in a semi-conductor?
a) Because of current flow
b) Because of diffusion current
c) Because of drift current
d) Because of difference in concentrations
View Answer
Answer: d
Explanation: As there is a different level of doping in the p and n regions of a semi-conductor, the carriers (either holes or electrons) move from a region of high concentration to a region of low concentration giving rise to diffusion current.

10. How does diffusion current produce the depletion region?
a) The diffusion causes the holes and electrons to collect at the junction
b) The diffusion is because of the depletion region
c) The depletion region aids diffusion

d) The statement is not true
View Answer
Answer: a
Explanation: The diffusion of carriers from one side to another makes the holes and electrons to collect on either side of the junction creating the depletion region. This is further widened or shortened depending on the biasing.

"Diffusion Capacitance".

1. On which of these does the diffusion capacitance of a diode not depend upon?
a) Forward current
b) Dynamic conductance
c) Doping concentration
d) Reverse resistance
View Answer
Answer: d
Explanation: C_D = εAW which means C_D ∝ 1W. Thus, C_D ∝ 1Doping√ concentration
C_D = τg = τr=τIFηVT
where τ = carrier life time, g = dynamic conductance, I_F = forward current.

2. If the diffusion capacitance is directly proportional only to the lifetime of holes in N side then ________
a) The diode is a p^+n junction diode
b) The diode is a pn^+ junction diode
c) The diode is a p^+n^+ diode
d) The diode can have any type of pn junction
View Answer
Answer: a
Explanation: Diffusion capacitance is proportional to the carrier lifetime of injected minority carriers / excess minority carriers. Since it is proportional to the lifetime of holes in N side, this means the N side is the minority and P side is the majority. Hence it is a p^+n diode.

3. Diffusion capacitance is larger than transition capacitance.
a) True
b) False
c) Both are same
d) Depends on doping concentrations
View Answer
Answer: b
Explanation: Diffusion capacitance occurs in a forward biased diode, transition capacitance is easy to see in reverse bias. $C_D > C_T$ for a forward bias junction. In reverse bias though, C_D may be neglected compared to C_T.

4. In a diode, the change in voltage being applied across it is 2V. The change in minority carriers outside the depletion region is 1.2×10^{-8}. Find diffusion capacitance.
a) 6 pF
b) 6 µF
c) 1.2 nF
d) 6nF
View Answer
Answer: d
Explanation: Diffusion capacitance = $\frac{dQ}{dV}$
$C_D = \frac{1.2x10^{-8}}{2}$
C_D = 6 nF.

5. The minority charge concentration can be represented as Q = V^2 – 33V. If the voltage being applied is now 5V, find the diffusion capacitance.
a) 1µF
b) 0.1µF
c) 10µF
d) 0.9µF
View Answer
Answer: b
Explanation: Q = – $\frac{V^{-9}}{9}$
$C_D = \frac{dQ}{dV} = V^{-10}$ = 1.024 x 10^{-7}
C_D = 0.1µF.

6. Consider two almost similar diodes, whose diffusion capacitances are C1 and C2, and doping concentrations of 1020 /cubic centimeter and 1016/cubic centimeter. Find $\frac{C1}{C2}$.
a) 100
b) 0.01
c) 10000
d) 0.0001
View Answer
Answer: b
Explanation: C ∝ $\frac{1}{\sqrt{Doping}}$
$\frac{C1}{C2} = \sqrt{\frac{10^{16}}{10^{20}}} = \sqrt{\frac{1}{10^4}} = \frac{1}{100}$
$\frac{C1}{C2}$ = 0.01.

7. If the relative permittivity of a diode remains constant, its area is doubled and its doping concentration is quadrupled. What is its new diffusion capacitance, of

originally it was C_D?
a) $4C_D$
b) $2C_D$
c) $3C_D$
d) C_D
View Answer
Answer: a
Explanation: C_D = εAW ∝ A.Doping−−−−−−√
C_D' = ε2AW ∝ 2A.2 2A.4Doping−−−−−−−√ = 4 C_D
$C_D' = 4C_D$.

8. Consider a step graded diode, which has built in voltage 0.7V, and depletion width 2μm. Depletion width is W2 when a reverse bias voltage of 11.3 V is applied. Find W2?
a) 8.28μm
b) 8μm
c) 4.14 μm
d) 9.88 μm
View Answer
Answer: a
Explanation: W1W2=V1V2−−−√=0.712−−−√
W2 = 4.14*2 = 8.28μm.

"Fermi Level in a Semiconductor having Impurities".

1. Which states get filled in the conduction band when the donor-type impurity is added to a crystal?
a) Na
b) Nd
c) N
d) P
View Answer
Answer: b
Explanation: When the donor-type impurity is added to a crystal, first Nd states get filled because it is of the highest energy.

2. Which of the following expression represent the correct formulae for calculating the exact position of the Fermi level for p-type material?
a) $E_F = E_V + kT\ln(N_D / N_A)$
b) $E_F = -E_V + kT\ln(N_D / N_A)$
c) $E_F = E_V - kT\ln(N_D / N_A)$
d) $E_F = -E_V - kT\ln(N_D / N_A)$
View Answer

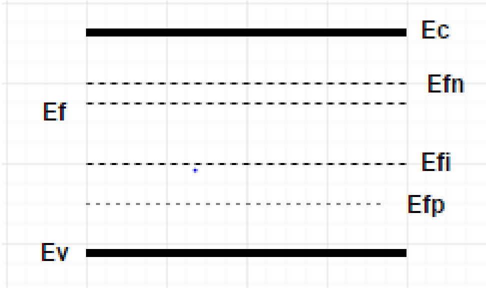
Answer: a
Explanation: The correct position of the Fermi level is found with the formula in the 'a' option.

3. Where will be the position of the Fermi level of the n-type material when $N_D=N_A$?
a) Ec
b) Ev
c) Ef
d) Efi
View Answer
Answer: a
Explanation: When $N_D=N_A$, $kT\ln(N_D/N_A)=0$
So,
Ef=Ec.

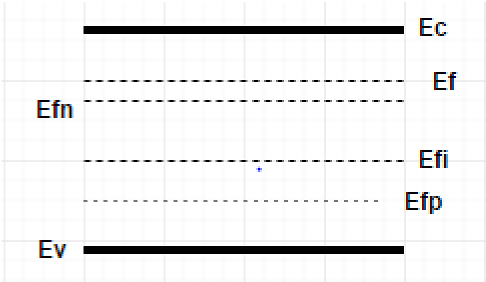
4. When the temperature of either n-type or p-type increases, determine the movement of the position of the Fermi energy level?
a) Towards up of energy gap
b) Towards down of energy gap
c) Towards centre of energy gap
d) Towards out of page
View Answer
Answer: c
Explanation: whenever the temperature increases, the Fermi energy level tends to move at the centre of the energy gap.

5. Is it true, when the temperature rises, the electrons in the conduction band becomes greater than the donor atoms?
a) True
b) False
View Answer
Answer: a
Explanation: When the temperature increases, there is an increase in the electron-hole pairs and all the donor atoms get ionized, so now the thermally generated electrons will be greater than the donor atoms.

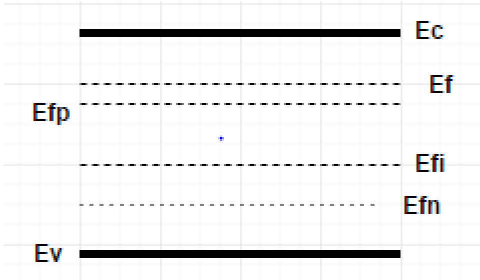
6. If the excess carriers are created in the semiconductor, then identify the correct energy level diagram.



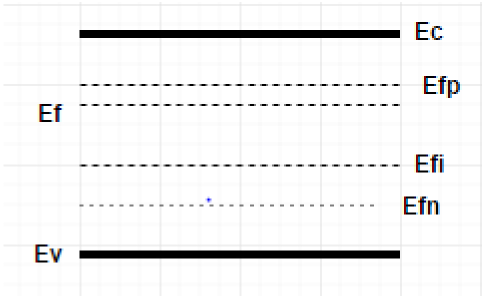
a) . .



b)



c)



d)

View Answer

Answer: a

Explanation: The diagram A refers the most suitable energy level diagrams because Efp>Ef>Efi>Efp>Ev.

7. If excess charge carriers are created in the semiconductor then the new Fermi level is known as Quasi-Fermi level. Is it true?

a) True

b) False

View Answer

Answer: a
Explanation: Quasi-fermi level is defined as the change in the level of the Fermi level when the excess chare carriers are added to the semiconductor.

8. Ef lies in the middle of the energy level indicates the unequal concentration of the holes and the electrons?
a) True
b) False
View Answer
Answer: b
Explanation: When the Ef is in the middle of the energy level, it indicates the equal concentration of the holes and electrons.

9. Consider a bar of silicon having carrier concentration n0=10^{15} cm^{-3} and ni=$10^{10}cm^{-3}$. Assume the excess carrier concentrations to be n=$10^{13}cm^{-3}$, calculate the quasi-fermi energy level at T=300K?
a) 0.2982 eV
b) 0.2984 eV
c) 0.5971 eV
d) 1Ev
View Answer
Answer: b

$$E_{Fn} - E_{Fi} = kTln\left(\frac{n_0 + \delta n}{n_i}\right)$$

Explanation:
=1.38*10^{-23}*300*ln(10^{13}+10^{15}/10^{13})
=0.2984 eV.

10. Consider a bar of silicon having carrier concentration n0=10^{15} cm^{-3}, ni=$10^{10}cm^{-3}$ and p0=$10^{5}cm^{-3}$. Calculate the quasi-fermi energy level in eV?
a) 0.1985
b) 0.15
c) 0.1792
d) 0.1
View Answer
Answer: c
Explanation: Using the same equation,

$$E_{Fi} - E_{Fp} = kTln\left(\frac{p + \delta p}{pi}\right)$$

Substituting the respective values,
E_{Fi} – E_{Fp}=0.1792 eV.

“Diffusion”.

1. What is the SI unit of electron diffusion constant?
a) cm^2/s

b) m^2/s
c) m/s
d) none
View Answer
Answer: b
Explanation: J=eDdn/dx
So D=q*m/ (q*s*(1/m))
$=m^2/s$.

2. Calculate the diffusion current density when the concentration of electron varies from the $1*10^{18}$ to $7*10^{17}$ cm^{-3} over a distance of 0.10 cm.D=$225cm^2/s$
a) 100 A/cm^2
b) 108 A/cm^2
c) 0.01A/cm^2
d) None
View Answer
Answer: b
Explanation: J=eDdn/dx
$J=1.6*10^{-19}*225*(10^{18}-(7*10^{17}))/0.1$
$=108A/cm^2$.

3. Which is the correct formula for the Jp?
a) Jp=qDdp/dx
b) Jp=pDdn/dx
c) Jp=-qDdp/dx
d) None
View Answer
Answer: c
Explanation: Jp is negative for the p type of semiconductors.

4. What is the direction of the electron diffusion current density relative to the electron flux?
a) Same direction
b) Opposite to each other
c) Perpendicular to each other
d) At 270 degrees to each other
View Answer
Answer: b
Explanation: From the graph between electron concentration and the distance, we can see that the direction of the electron diffusion current density is opposite to the electron flux.

5. In diffusion, the particles flow from a region of ______ to region of __________
a) High, low
b) Low , high
c) High , medium
d) Low, medium
View Answer
Answer: a
Explanation: Diffusion is the process of flow of particles form the region of the high concentration to a region of low concentration.

6. Which of the following parameter describes the best movement of the electrons inside a semiconductor?
a) Velocity gradient
b) Diffusion
c) Mobility
d) Density gradient
View Answer
Answer: c
Explanation: Mobility is defined as the movement of the electrons inside a semiconductor. On the other hand, velocity gradient is the ratio of velocity to distance.

7. Which of the following term isn't a part of the total current density in a semiconductor?
a) Temperature
b) μ
c) e
d) E
View Answer
Answer: a
Explanation: $J=en\mu E+ep\mu E+eDdn/dx-eDdp/dx$
So, temperature isn't a part of the equation.

8. What does dn/dx represent?
a) Velocity gradient
b) Volume gradient
c) Density gradient
d) None
View Answer
Answer: c
Explanation: dn/dx represent velocity gradient.

9. Calculate the diffusion constant for the holes when the mobility of the holes is $400cm^2$/V-s and temperature is 300K?
a) 1.035m m^2/s
b) 0.035m m^2/s
c) 1.5m m^2/s
d) 1.9m m^2/s
View Answer
Answer: a
Explanation: $D_p=V_T*\mu n$
$= (1.38*10^{-23}*300*400*10^{-2})/ (1.6*10^{-19})$
= 1.035m m^2/s.

10. Calculate the diffusion constant for the electrons when the mobility of the electrons is $325cm^2$/V-s and temperature is 300K?
a) 0.85 m^2/s
b) 0.084 m^2/s
c) 0.58 m^2/s
d) 0.95 m^2/s
View Answer
Answer: c
Explanation: $D_n=V_T*\mu n$
$= (1.38*10^{-23}*300*325*10^{-2})/ (1.6*10^{-19})$
= 0.084 m^2/s.

"Fermi-Dirac Distribution".

1. Fermi-Dirac statistics is for the ________
a) Distinguishable particles
b) Symmetrical Particles
c) Particles with half integral spin
d) Particles with integral spin
View Answer
Answer: c
Explanation: The Maxwell-Boltzmann statistics is for the distinguishable particles, which are basically the classical particles like atoms and molecules.

2. The difference between fermions and bosons is that bosons do not obey ______
a) Aufbau principle
b) Pauli's Exclusion Principle
c) Hund's Rule of Maximum Multiplicity
d) Heisenberg's Uncertainty Principle
View Answer
Answer: b
Explanation: The particles that follow Pauli's Exclusion Principle are defined as Fermions while that don't are called bosons. Bosons have an integral spin number.

3. The Maxwell-Boltzmann law is given by the expression n_i = ________
a) $ge^{\alpha+\beta E}$
b) $ge^{\alpha+\beta E}-1$
c) $ge^{\alpha+\beta E}+1$
d) $ge^{\alpha+\beta E}+k$
View Answer
Answer: c
Explanation: The correct expression for the Maxwell-Boltzmann law is n_i = $ge^{\alpha+\beta E}+1$, where α depends on the volume and the temperature of the gas and β is equal to 1/kT.

4. The wave function of fermions is not ________
a) Continuous
b) Single Valued
c) Symmetric
d) Differentiable
View Answer
Answer: c
Explanation: The particles which have antisymmetric wave function having half odd integral spin number and obey Pauli's principle are called fermions.

5. Fermi-Dirac statistics cannot be applied to ________
a) Electrons
b) Photons
c) Fermions
d) Protons
View Answer
Answer: b
Explanation: Fermi-Dirac Statistics can be applied to particles having half odd integral spin number and obey Pauli's principle which are electrons, fermions and protons. Photon has an integral spin number.

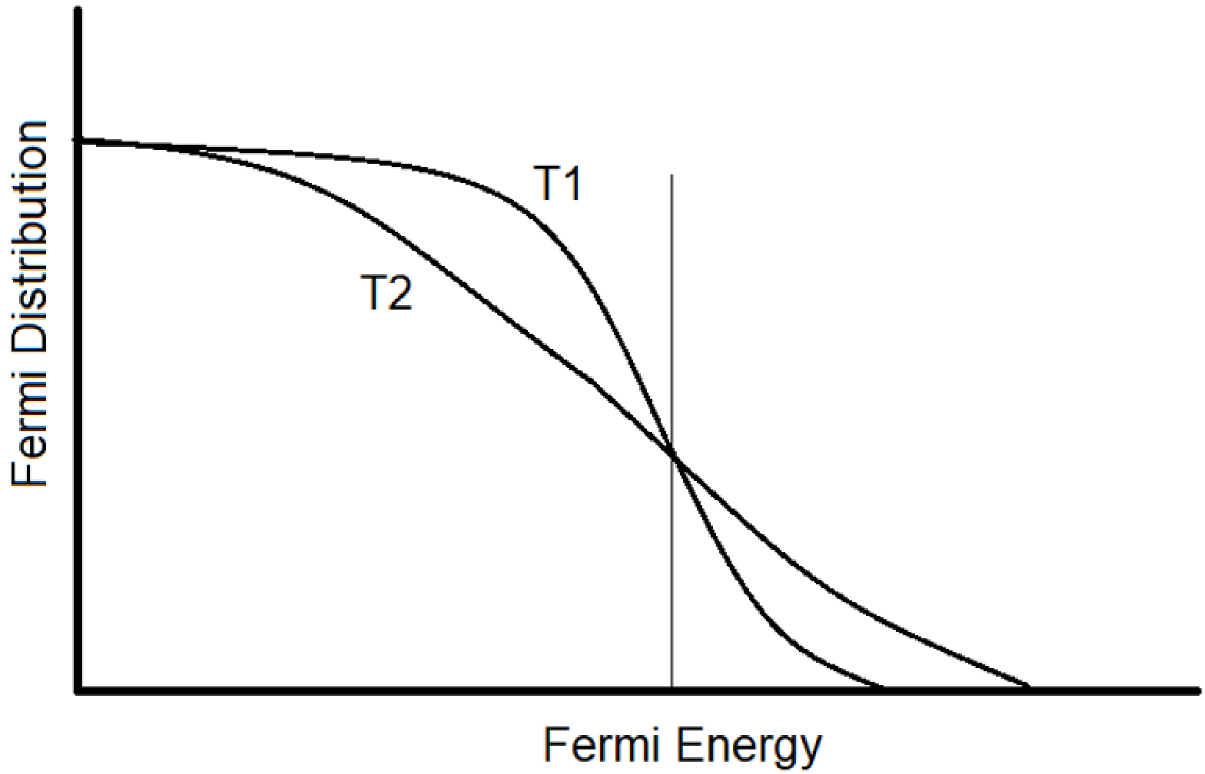
6. The distribution function is given by ________
a) $1Ae^{EnT}+1$
b) $1Ae^{EnT}-1$
c) $1e^{EnT}+A$
d) $1e^{EnT}-A$
View Answer
Answer: a
Explanation: The distribution function is given by $1Ae^{EnT}+1$, where A = e^{-EFnT} The energy E_F is called the Fermi energy and is constant for a given system.

7. At T > 0K, the probability of a state with $E > E_F$ filled is zero.
a) True
b) False
View Answer
Answer: b
Explanation: At T > 0 K, the probability that a state with $E > E_F$ is filled is ½. Hence, fermi energy is the energy at which the probability of occupation is ½ at any temperature above 0 K.

8. The expression for mean energy is given by ________
a) $35NE_F$
b) $25NE_F$
c) $35E_F$
d) $25E_F$
View Answer
Answer: a
Explanation: The expression for the mean energy of an electron at absolute zero is given by $35NE_F$. The expression $35E_F$ is called the zero point energy.

9. For all the quantum states with energy greater than Fermi energy to be empty in a Fermi-Dirac system, the temperature should be ______
a) 273 K
b) 373 K
c) 0 K
d) 100 K
View Answer
Answer: c
Explanation: We know that the Fermi-Dirac distribution is given by:
$F_{FD}(E)$ = 1eE−EFnT+1
For all the quantum states with energy greater than Fermi energy to be empty,
$F_{FD}(E) = 0$, for $E > E_F$ and $F_{FD}(E) = 1$, for $E < E_F$
Therefore, for $E < E_F$ 1eE−EFnT+1=1
eE−EFnT=0
As, $E < E_F$, $E- E_F < 0$. Therefore, to satisfy the given statement,
T = 0 K
Thus, we can define Fermi energy as the energy of the uppermost occupied level at 0 K.

10. What is the relationship between T1 and T2?



a) T1 > T2
b) T1 < T2
c) T1 = T2
d) Insufficient Information
View Answer
Answer: b
Explanation: The given figure shows the variation of Fermi-Dirac distribution with energy E. In this case, T2 > T1, according to the expression: $F_{FD}(E) = \frac{1}{e^{\frac{E-E_F}{nT}}+1}$.

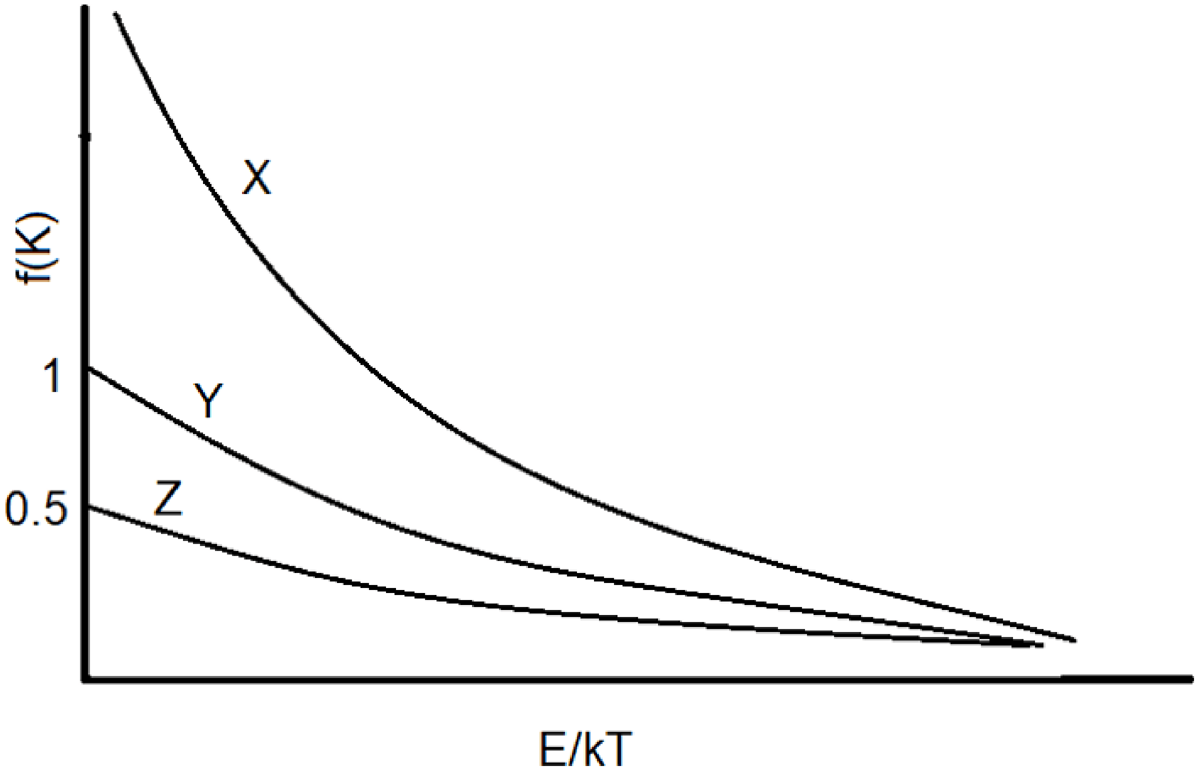
11. The density of silver is 10.5 g/cm^3 and its atomic weight is 108. If each atom contributes one electron for conduction, what is the fermi energy?
a) 2.12 eV
b) 3.31 eV
c) 4.69 eV
d) 5.51 eV
View Answer
Answer: d
Explanation: Fermi Energy, $E_F = \frac{h^2}{8m}\left(\frac{3N}{\pi v}\right)^{2/3}$
Here, N /V = 10.5 X 6.02 X 10^{23}/108
= 5.85 X 10^{28} m^{-3}
Therefore, $E_F = \frac{6.626 X 6.626}{8 X 9.1 \times 10^{-19}} \times \left(\frac{3 \times 5.585}{\pi}\right)^{2/3}$
= 8.816 X 10^{-19}J
= 5.51 eV.

12. The Fermi energy of a material is 3.45 eV. What is the zero-point energy of the material?
a) 1.02 eV
b) 2.07 eV
c) 3.45 eV
d) 4.16 eV
View Answer
Answer: b
Explanation: As we know, the fermi energy of the material is 3.45 eV.
Now, zero-point energy =$35E_F$
= 3/5 X 3.45 eV
= 2.07 eV.

13. The average energy of one electron silver is 3.306 eV. What is the fermi-energy of Silver at 0 K?
a) 2.32 eV
b) 3.78 eV
c) 4.12 eV
d) 5.51 eV
View Answer
Answer: d
Explanation: We know, Average Energy, E =$35NE_F$
Here, E = 3.306 eV, N = 1
Therefore, we get: E_F = 5E/3
= 5.51 eV.

14. In Fermi-Dirac Statistics, one energy state can be occupied by more than one particle.
a) True
b) False
View Answer
Answer: b
Explanation: In Fermi-Dirac statistics, one energy state can be occupied by only one particle. Therefore, when one state is filled, the particle will go on to another state.

15. Which of the following is the curve for Fermi-Dirac statistics?



a) X
b) Y
c) Z
d) None
View Answer
Answer: c
Explanation: As seen the curve the order of the ration of f(K) with E/kT is in the order X > Y > Z. Here, Y is Maxwell-Boltzmann Statistics, X is Bose-Einstein Statistics and Z is Fermi-Dirac Statistics.

Diodes".

1. Silicon and germanium are called ___________ semiconductors.
a) direct gap
b) indirect gap
c) band gap
d) indirect band gap
View Answer
Answer: b
Explanation: The forbidden energy gap for silicon and germanium are respectively 1.21 eV in Si and 0.79 eV in germanium. Silicon and germanium are called indirect gap semiconductors because the bottom of the conduction band does not lie directly above the top of the valence band.

2. GaAs is used in the fabrication of GUNN diodes because:
a) GaAs is cost effective
b) It less temperature sensitive
c) it has low conduction band electrons
d) less forbidden energy gap
View Answer
Answer: d
Explanation: In GaAs, the conduction band lies directly above the top of the valence band. The lowest energy conduction band in GaAs is called as primary valley. GaAs consists of six secondary valleys. The bottom of one of the secondary valley is at an energy difference of 0.35 eV with the bottom of the primary valley in conduction band.

3. In a GaAs n-type specimen, the current generated is constant irrespective of the electric filed applied to the specimen.
a) true
b) false
View Answer
Answer: b
Explanation: In a GaAs n-type specimen, when the electric field applied reaches a threshold value of E_{th}, the current in the specimen becomes suddenly oscillatory and with respect to time and these oscillations are in the microwave frequency range. This effect is called Gunn Effect.

4. When the electric field applied to GaAs specimen is less than the threshold electric field, the current in the material:
a) increases linearly
b) decreases linearly
c) increases exponentially
d) decreases exponentially
View Answer
Answer: a
Explanation: When the electric field applied is less than the threshold value of electric field, the electrons jump from the valence band to the primary valley of the conduction band and current increases linearly with electric field.

5. When the applied electric field exceeds the threshold value, electrons absorb more energy from the field and become:
a) hot electrons
b) cold electrons
c) emission electrons

d) none of the mentioned
View Answer
Answer: a
Explanation: When the applied electric field exceeds the threshold value, electrons absorb more energy from the field and become hot electrons. These electrons jump into the lowest secondary valley in the conduction band. When the electrons become hot, their mobility reduces.

6. GaAs is used in fabricating Gunn diode. Gunn diode is:
a) bulk device
b) sliced device
c) made of different type of semiconductor layers
d) none of the mentioned
View Answer
Answer: a
Explanation: A GUNN diode is a bulk device, that is, it does not contain any junction but it is a slice of n-type GaAs. P-type GaAs does not exhibit Gunn Effect. Hence it is a reversible and can be operated in both directions.

7. The electrodes of a Gunn diode are made of:
a) molybdenum
b) GaAs
c) gold
d) copper
View Answer
Answer: a
Explanation: Gunn diode is grown epitaxially onto a gold or copper plated molybdenum electrode, out of gallium arsenide doped with silicon, tellurium or selenium to make it n-type.

8. When either a voltage or current is applied to the terminals of bulk solid state compound GaAs, a differential ______ is developed in that bulk device.
a) negative resistance
b) positive resistance
c) negative voltage
d) none of the mentioned
View Answer
Answer: a
Explanation: When either a voltage or current is applied to the terminals of a sample of bulk solid state compound formed by group 5 and 3 elements of periodic table, a differential resistance is developed in the bulk device. This fundamental concept is called RWH theory.

9. The number of modes of operation for n type GaAs is:
a) two
b) three
c) four
d) five
View Answer
Answer: c
Explanation: n-type GaAs used for fabricating Gunn diode has four modes of operation. They are Gunn oscillation mode, limited space charge accumulation mode, and stable amplification mode bias circuit oscillation mode.

10. The free electron concentration in N-type GaAs is controlled by:
a) effective doping
b) bias voltage
c) drive current
d) none of the mentioned
View Answer
Answer: a
Explanation: The free electron concentration in n-type GaAs is controlled through effective doping so that they range from 10^{14} to 10^{17} per cc at room temperature. The typical specimen of n-type GaAs has the dimensions 150 μm by 150 μm.

11. The modes of operation of a Gunn diode are illustrated in a plot of voltage applied to the Gunn diode v/s frequency of operation of Gunn diode.
a) true
b) false
View Answer
Answer: b
Explanation: A graph of plot of product of frequency and the length of the device plotted along y-axis versus the product of doping concentration and length along X-axis. These are the parameters on which the four modes of operation of Gunn diode are explained.

12. The mode of operation in which the Gunn diode is not stable is:
a) Gunn oscillation mode
b) limited space charge accumulation mode
c) stable amplification mode
d) bias circuit oscillation mode
View Answer
Answer: a
Explanation: In Gunn oscillation mode, the device is unstable due to the formation of accumulation layer and field domain. This high field domain moves from cathode to anode.

13. The frequency of oscillation in Gunn diode is given by:
a) v_{dom}/ L_{eff}

b) L_{eff}/ V_{dom}
c) L_{eff}/ WV_{dom}
d) none of the mentioned
View Answer
Answer: a
Explanation: In Gunn oscillation mode, the frequency of oscillation is given by v_{dom}/ L_{eff}, where v_{dom} is the domain velocity, L_{eff} is effective length that the domain moves from the time it is formed until the time a new domain is formed.

14. In Gunn diode oscillator, the Gunn diode is inserted into a waveguide cavity formed by a short circuit termination at one end
a) true
b) false
View Answer
Answer: a
Explanation: The Gunn diode is mounted at the centre of the broad wall of a shorted waveguide since for the dominant TE10 mode; the electric field is maximum at the centre.

15. In a Gunn diode oscillator, the electron drift velocity was found to be 107 cm/second and the effective length is 20 microns, then the intrinsic frequency is:
a) 5 GHz
b) 6 GHz
c) 4 GHz
d) 2 GHz
View Answer
Answer: a
Explanation: The intrinsic frequency for a Gunn oscillator is given by V_d/L. Here V_D is the drift velocity and L is the effective length. Substituting the given values in the above equation, intrinsic frequency is 5 GHz.

“Fermi Level in a Semiconductor having Impurities”.

1. Which states get filled in the conduction band when the donor-type impurity is added to a crystal?
a) Na
b) Nd
c) N
d) P
View Answer
Answer: b
Explanation: When the donor-type impurity is added to a crystal, first Nd states get filled because it is of the highest energy.

2. Which of the following expression represent the correct formulae for calculating the exact position of the Fermi level for p-type material?

a) $E_F = E_V + kTln(N_D / N_A)$

b) $E_F = -E_V + kTln(N_D / N_A)$

c) $E_F = E_V – kTln(N_D / N_A)$

d) $E_F = -E_V – kTln(N_D / N_A)$

View Answer

Answer: a

Explanation: The correct position of the Fermi level is found with the formula in the 'a' option.

3. Where will be the position of the Fermi level of the n-type material when $N_D=N_A$?

a) Ec

b) Ev

c) Ef

d) Efi

View Answer

Answer: a

Explanation: When $N_D=N_A$, $kTln(N_D/N_A)=0$

So,

Ef=Ec.

4. When the temperature of either n-type or p-type increases, determine the movement of the position of the Fermi energy level?

a) Towards up of energy gap

b) Towards down of energy gap

c) Towards centre of energy gap

d) Towards out of page

View Answer

Answer: c

Explanation: whenever the temperature increases, the Fermi energy level tends to move at the centre of the energy gap.

5. Is it true, when the temperature rises, the electrons in the conduction band becomes greater than the donor atoms?

a) True

b) False

View Answer

Answer: a

Explanation: When the temperature increases, there is an increase in the electron-hole pairs and all the donor atoms get ionized, so now the thermally generated electrons will be greater than the donor atoms.

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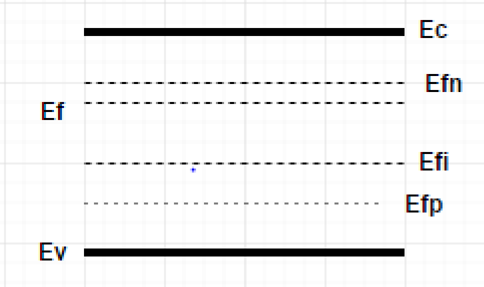
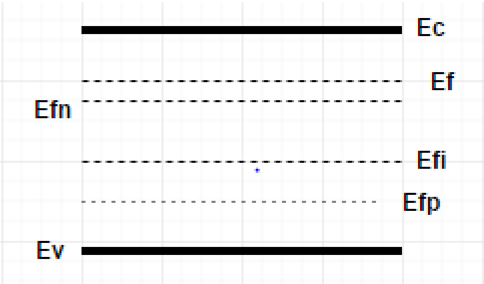
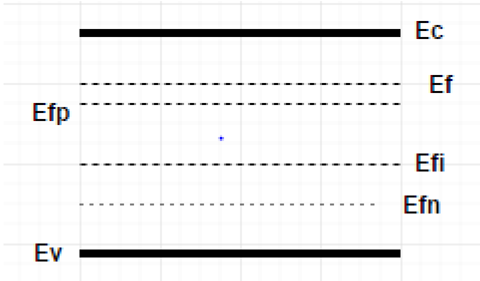
6. If the excess carriers are created in the semiconductor, then identify the correct energy level diagram.



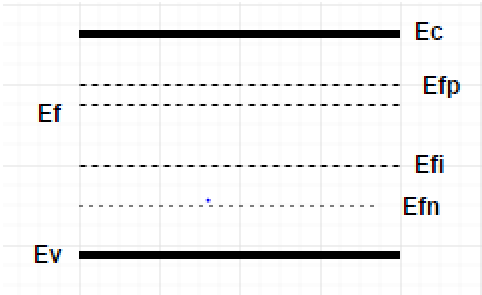
a) . .



b)



c)



d)

View Answer

Answer: a

Explanation: The diagram A refers the most suitable energy level diagrams because Efp>Ef>Efi>Efp>Ev.

7. If excess charge carriers are created in the semiconductor then the new Fermi level is known as Quasi-Fermi level. Is it true?

a) True

b) False
View Answer
Answer: a
Explanation: Quasi-fermi level is defined as the change in the level of the Fermi level when the excess chare carriers are added to the semiconductor.

8. Ef lies in the middle of the energy level indicates the unequal concentration of the holes and the electrons?
a) True
b) False
View Answer
Answer: b
Explanation: When the Ef is in the middle of the energy level, it indicates the equal concentration of the holes and electrons.

9. Consider a bar of silicon having carrier concentration n0=10^{15} cm^{-3} and ni=$10^{10}cm^{-3}$. Assume the excess carrier concentrations to be n=$10^{13}cm^{-3}$, calculate the quasi-fermi energy level at T=300K?
a) 0.2982 eV
b) 0.2984 eV
c) 0.5971 eV
d) 1Ev
View Answer
10. Consider a bar of silicon having carrier concentration n0=10^{15} cm^{-3}, ni=$10^{10}cm^{-3}$ and p0=$10^{5}cm^{-3}$. Calculate the quasi-fermi energy level in eV?
a) 0.1985
b) 0.15
c) 0.1792
d) 0.1
View Answer
Answer: c
Explanation: Using the same equation,

$$E_{Fi} - E_{Fp} = kTln\left(\frac{p+\delta p}{pi}\right)$$

Substituting the respective values,
E_{Fi} – E_{Fp}=0.1792 eV.